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"Roads and Streets" Passes the 17,000 Mark

In our January issue we said: "The paid circulation of Roads and Streets has had a phenomenal growth, and no let up is yet in sight. It will surely exceed 15,000 before the frost is out of the ground, and is likely to be 18,000 when another January rolls around."

That this was a conservative forecast is shown by the fact that our net paid circulation passed the 17,000 mark in June. It now seems probable that when our next Road Show issue goes to press in January, our net paid circulation will be 20,000 or more.

Speaking of the Road Show, we plan an innovation with respect to our Road Show issue. That issue will be devoted to the description of new and improved equipment for building and maintaining highways, together with accounts of new developments in road building materials. Our aim will be to carry the Road Show to all our subscribers and 10,000 other highway designers, builders and maintenance superintendents.

Although an attendance of about 30,000 is expected at the next Road Show there will be many thousands who will be unable to go to Cleveland; and to them our Road Show issue should be especially instructive. Even to those who attend the exposition our Road Show issue should be interesting, for it will epitomize the progress in the art of building roads with machinery.

The Immigration of Research Technicians

"After eight years as engineer and head of the research bureau of the Royal Board of Water Falls in Stockholm, Sweden, Dr. Harold Nordiner is now a consulting engineer for the Westinghouse Electric and Manufacturing Co." He has invented an oscillograph for automatically recording voltage surges on power lines, due to lightning or analogous causes.

Dr. Nordiner's immigration to America is typical of that of hundreds of European scientists and engineers since the end of the world war. Many of our large manufacturing companies have developed great research departments that are constantly growing, and with their growth comes an increased demand for experienced research engineers. It takes no marked prophetic instinct to forecast a steadily increasing flow of research technicians into this country from all the countries of the world, for here is the greatest chance for fortune and for fame.

Since our unexampled prosperity is founded upon the work of our original men, aided by freedom from restrictions to individual enterprise, it follows that the most certain way of accelerating our march toward universal wealth consists not only in training and employing more of our own engineers as research technicians but in attracting to our shores as many of the most brilliant foreign originators as possible.

The other day a celebrated English scientist, speaking about astronomical progress, said that astronomy might almost be called "that American science." Our highly endowed observatories have made so many discoveries in recent years that the astronomers of Europe look enviously upon the instruments that our astronomers possess. Yet, great as our telescopes are, still greater are planned. Miss Proctor, daughter of a celebrated American astronomer, is now engaged in canvassing the country for ten million dollars with which to build a telescope that will make all others seem to it, as Galileo's first little tube with its spectacle lenses seems to the hugest telescope now in use. Who can doubt that with such an instrument there will unfold many a hidden galaxy vastly greater than our own? And with the discovery of countless new star systems there will also come knowledge of their mutual relationship and their common origin.

Most astronomers now believe that the spiral nebulae are "island universes," or galaxies similar to our galaxy that is "bounded" by the milky way. They explain the fact that spiral nebulae decrease in number as the telescope points more nearly toward the milky way, on the hypothesis that star dust in the vicinity of the milky way obscures the vision. But it is not unlikely that the real reason is this: As the axis of Uranus and the axis of the orbits of its moons point toward the sun, so may the axis of our whole galaxy point toward a stupendous star about which our galaxy revolves, and about which other galaxies (the spiral nebulae) also revolve. This hypothesis explains why the number of spiral nebulae increases as the angle from the milky way increases. The building of the Proctor telescope would probably answer this and many other enigmas; and with the answers would come many a piece of knowledge applicable in everyday affairs, leading to

greater and greater prosperity. Let it never be forgotten that Newton's theories of the mechanism of star motions under the action of gravitation and centrifugal force stands second to none in the development of man's knowledge of practical mechanics. Remember also that helium gas was discovered in the sun before its existence on earth was suspected, and that helium is now secured as a by-product from gas wells in Texas and is used in place of hydrogen in balloons.

All nature is so intimately interwoven that a discovery in one realm often throws a flood of light upon some obscure fact in a realm so remote that the two seemed forever separated. For example, who would have dreamed that the history of climatic changes could be read in the periodic variation in the thickness of tree rings, and that this variation in turn would give the history of sunspot variation, which in turn would furnish evidence that planets cause sunspots?

The student of the history of science soon becomes familiar with its unfailing economic fruitfulness, but unfortunately this characteristic is not generally appreciated even by educated men. Were it fully appreciated every large manufacturer would have a scientific research laboratory, and small manufacturers would cooperate in financing and operating similar laboratories. There are said to be 1,000 research laboratories now in America, but most of these are doubtless engaged on problems relating solely to the immediate business needs of their supporters. This, of course, is a step in the right direction, but until researchers are also given free rein to drive the chariots of their imagination wheresoever they will, the greatest fruitfulness of research can not be attained.

Because Europe, particularly in Germany and England, has long been superior to America in the development of pure science it is the part of wisdom not only to read the works of her brilliant discoverers, but to induce many of them to take residence among us.

The True Significance of an America on Wheels

Los Angeles, with a population of one and a quarter million, has more automobiles than the total of four nations having a combined population of two hundred million, namely, Italy, Spain, Russia and Japan. The total motor vehicle registration in Los Angeles is 430,000 in round numbers.

If such statistics lack impressiveness because the comparison is made with countries that are relatively poor, then consider the following totals of registered motor cars:

Germany	422,300
Australia	423,500
Argentina	241,400

The true significance of great motor vehicle registration throughout America lies in the disclosure of the high average incomes of her people. Nearly all our states have at least one motor car per family. Los Angeles county leads all sections, but not by any enormous margin, with one and a third cars per family. In the nations of Europe, few people, other than those classed there as wealthy, own motor cars. Hence, by their standards of wealth, nearly every American is rich. Even by our own standards of a generation ago, most of us are rich.

There is a marked tendency abroad to attribute our prosperity to our natural resources and the world war. The latter aided us not a particle, but really halted our productive increase. The former, namely, our natural resources, is to be found in sufficient abundance in almost every country possessed of large area. Moreover, England has demonstrated that a great manufacturing nation can readily bring to her factories the raw materials of the world as long as her workers remain highly productive. When, through labor union restrictions and socialistic repression of individual enterprise England began to fall behind in per capita productivity, then, and not till then, were loud complaints made as to her paucity of natural resources. Let her once more return to a status of industrial freedom, and it will not be many years before she, too, will be a nation on wheels.

An Engineer as President

Our first American president was a surveyor in his youth, and a good business man always. Our next president will probably be a graduate technical engineer, and likewise a good business man.

The editorial writers have not been slow to see the significance of the entrance of an engineer into the contest for the highest executive position in this country. For example, the Vancouver Sun says:

"Mr. Hoover represents the new order of men that is growing up on the North American continent. . . . Because he is the first real representative of scientific and economic America, it is now up to that fine civilization for which he stands to help in every way it possibly can to elect Hoover."

Since engineering is the application of science to economic problems, it is but a short step from mining engineering to political engineering, as Hoover has already abundantly proved in his administration of the department of commerce.

William Allen White in reporting the convention at Kansas City said:

"In the memory of men now living the Republican party has picked its leader from every walk of life. The lawyer, the farmer, the soldier, the college professor, the ranchman and writer, the career man in politics, the country editor, the small lawyer, all have led the Republican party. And now enters the engineer."

Yes, "now enters the engineer," and with his entrance into political prominence there will be focused, as never before, the eyes of a nation upon what engineering really is. Probably the average person now has only the vaguest conception of civil engineering or of any other branch of engineering. Equally vague to most men is the meaning of the word science. It will be a golden opportunity during the next four years to define, explain and illustrate the meaning of these two great words—science and engineering. If the public can once secure a full appreciation of their significance, our vaunted industrial progress of the past century will seem a century hence like the creeping of a child in swaddling clothes; for an enlightened public will educate its brightest sons as scientists and engineers, will richly endow thousands of research laboratories, and will thus enable its creative minds to bend Nature to the utmost service to mankind.

H. P. Gillette

Using Duplicate Outfits On Fifteen Mile 40-ft. State Highway

Grading and Paving Methods Used on 40-Ft. Road in DuPage County, Ill.

A NEW 40-ft. concrete state highway, known as Route 64, is under construction in the State of Illinois. This highway will provide a new direct route from Sycamore through St. Charles, Ill., in the Fox River Valley, to connect with North Ave., at the city limits of Chicago, and will provide a more direct route to take a great deal of the traffic hitherto carried by the longer and more winding St. Charles Road, which is for a great part unpaved. An advantage of the new route is that it does not pass through any communities in DuPage County as does the older road, and consequently will make for faster moving traffic, through rolling farming country, thus making a more practical through route for all traffic. Several grade crossings are unavoidably involved, but separations will be considered for as many of these as possible. The part of the route now being paved comprises a total length of 16 miles in DuPage County, from the west county line to the east county line, except for several omissions at grade crossings and the like that cut down the actual mileage of pavement now being laid to about 15 miles. Other portions of the highway, in De Kalb, Kane and Cook Counties, are to be let under separate contracts. The section being used from St. Charles to Elmhurst is that shown in Fig. 3, the standard 40-ft. section of the Illinois highway department.

Rough Grading.—Rough grading on this job was done with steam shovels and an elevating grader outfit. Four shovels were used, one Harnischfeger Corporation (P. & H.) one yard shovel, one Northwest 1-yd. shovel, one Koehring 1-yd. shovel, and a General ⅝-yd. shovel. Part of the shovel loading was done into a fleet of 4-yd. motor trucks, while two shovels were served by six 10-ton Caterpillar tractors and a Cletrac pulling strings of 5-yd. LaPlante-Choate steel dump wagons. These wagons were used in three strings of two wagons each to the Caterpillar tractor. Balance points were from 200 to 1,500 ft., with one as long as 2,000 ft., and with overhaul figured for all balance points over 500 ft.

The shovel outfits, each consisting of a foreman, a shovel operator, 1 pit man, and one driver for each truck, operated the shovel-truck outfits, while the shovel-tractor outfits, besides the shovel gang, required 1 bulldozer-tractor operator on the dump, 1 dump man, and a tractor operator for each tractor. This organization could average 800 cu. yd. of dirt per ten hour day in the yellow clay light cuts, some of which contained stones as large as a foot in diameter.

The elevating grader outfit was served by 9 two-yard motor trucks, and included one Caterpillar operator, 1 grader operator, a driver for each truck, one dump man, and one bulldozer operator. This outfit could average 1,200 cu. yd. per day.

Fine Grading.—Fine grading was done with a fleet of 6 Fordsons pulling Miami wheeled scrapers, an International tractor pulling a plow, and two one-man graders, tractor power, equipped with 7 ft. blades. Cleanup ahead of the subgrader was done with a team outfit operating two 3-up fresnos and three 2-up slip scrapers. Subgrading was done with an A. W. French subgrader ahead of each paver. This machine required the services of 1 operator and from 2 to 4 laborers, depending upon how much stone was encountered.

Paving Operations.—Because of the time limit involved, two separate and essentially duplicate paving organizations were used, one working east of the camp and one working west of that central point. Each had its material

Fig. 1.—Fine Grading Equipment Includes an A. W. French Subgrader, a Light Roller, and Scraper

Fig. 2.—This Machine was Used to Cut Trench for the Road Forms

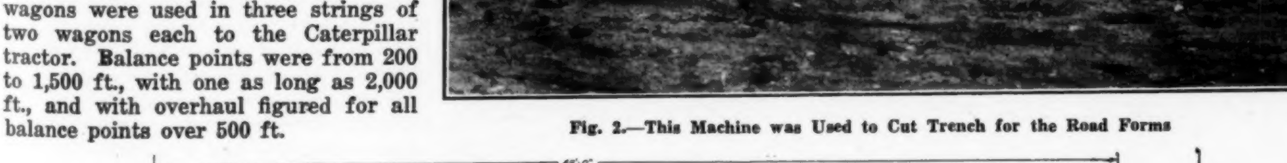


Fig. 3.—Section Used on this 40 ft. Highway

Fig. 4.—General View of Batching Outfit, with Cement Cars on the Left, Gravel Stockpile, Bins, Aggregate Cars over Track Hopper, and Sand Pile. The Crane is Between the Bins and the Track Hopper

Fig. 5.—End View of Same Plant Showing Relative Location of Track Hopper, Stock Piles, Crane, and Bins, Looking from Cement Cars

Fig. 6.—View at Paver Showing Extended Boom

supply, batching plant, and paving equipment and crew.

Type of Batching Plant.—The batching plant visited presented a very neat layout based on delivery of materials by rail, bottom dump cars of sand and gravel were spotted on a siding that was laid for the purpose, and cars were unloaded by simply opening the bottom gates and letting the aggregates flow into a track hopper that had been excavated for the purpose and lined with lumber. Each hopper had a capacity of four carloads, with separate adjoining hoppers for sand and gravel. A P. & H. Model 206 clamshell crane stationed on the side of the hoppers opposite to the track then picked up the aggregates from the hoppers and piled them into stockpiles along the track at either end of the hoppers. A set of Butler bins holding 15 yd. gravel and 10 yd. of sand, was erected beyond this crane so that the crane was situated between the track hoppers and the steel bins that served the batchers. Then as rapidly as required, the crane could load the bins from either the track hoppers or stockpiles as required. The stockpiles then served as an ample reservoir to keep the paver supplied even should the always uncertain delivery of aggregates break down altogether for a day or more.

Between this batching plant and the road, the cement cars were also spotted, so that the cement could be spread on the aggregate with but one handling from the car, with the trucks driving up to the car door. This method is of course cheaper than erecting a cement shed and handling the cement twice.

Force Required.—Each plant required the services of 2 car laborers, one clamshell operator, one batcher, one dump man, one roadway laborer, and from 2 to 3 cement hands, all in charge of a foreman. With this plant and organization, a total of 1,000 cu. yd. of material could be handled in an 8 hour day.

Paving.—The batches proportioned at these plants were delivered to the pavers in a fleet of 14 to 18 International Special 2-batch trucks. The average haul from one plant was 1½ miles, while the average haul from the other plant, as set up, was 3 miles.

The concrete was mixed at each outfit in a Koehring 27E paver. These pavers were equipped with an extension on the boom, rigged up in the blacksmith shop at the camp, and were thus enabled to work on the side of the subgrade not being paved at the time, obviating tearing up of the prepared subgrade by trucks and by the paver itself.

A tripod arrangement was rigged up to support the free end of the boom.

The method used was to first pave one-half of the road, let it cure, and then use the completed strip to carry paver and trucks in paving the remaining strip. This method of planning the work is expected to result in a good saving of labor which would otherwise have to be expended in dressing up the subgrade between the paver and the finishing machine just prior to spreading the concrete.

Water.—A two-inch water line was laid, and equipped with gate valves and connections at frequent intervals. Pressure was regulated by means of a length of pipe, plugged at the upper end, connected vertically in the line at one of the hose connections.

Finishing.—Just ahead of the mixing machine a scratch template was used to check up on the subgrade and insure final grade. Concrete was then spread and finished with an Ord finishing machine at one outfit and with a Lakewood at the other. Hand floats and other tools were used for final finishing. The finished slab was then covered with wet burlap until the following morning, when about 2½ lb. of calcium chloride was spread on each sq. ft. of surface for final curing.

Forms.—It is interesting to note that the trenches for the road forms were cut by means of a Carr formgrader. This is a tractor-power machine that uses an auger cutting head and worm to cut the trench for the forms to line and grade and convey the dirt to the shoulder, all in one operation. A wire is used to give line and grade, and a pointer on the device, when kept on this line, automatically gives both line and grade. Practically no handwork is said to be necessary, and it is said to be possible to cut and set 1,200 lin. ft. of forms per 10 hour day, with a force of 1 operator, 1 helper, and 2 laborers, including necessary hand labor. Trouble, however, is experienced when heavy gravel is encountered, and more handwork is needed.

Paving Forces.—The crew needed at the paving operation includes one mixer operator, one finishing machine operator who also operates the gasoline roller, 1 man on the scratch template, 1 dump man, 4 spaders, two men on center strips and steel, two form graders on the machine, two cement finishers, and two men on chloride and burlap.

With the six bag batch of 1:2:3½ mix corrected with 15 per cent additional sand and 6 per cent additional gravel, on the average, to allow for moisture, and with water content to give the right workability with the finishing machine, and with the organization already described, it has been found possible to average 800 lin. ft. of 20 ft. concrete per day. One day, 1031½ lin. ft. were laid in 10 hours.

Camp.—While most of the men come out from town every day, a camp is maintained for the convenience of those who wish to stay there and to serve meals to both classes of men. This camp is maintained under sub-contract by the Wilson Commissary Co., Chicago. The sleeping quarters are unusually comfortable, with clean linen supplied each week, and regular steel beds to sleep on, while the meals served are well worth while. It is the policy of this company, who have a collective buying arrangement with sources of supply, to serve nationally advertised brands of food products, and to sell advertised brands of merchandise as well, at cost, in the canteen. About 500 regular boarders and as many as 100 dinner boarders are served each day, at a price of $14.00 per week for room and board for regular boarders and a rate of 70 ct. for dinners for all others. The mess hall is manned by one cook, one dishwasher, 2 waiters, and one yard man, all in charge of a foreman representing the commissary company.

The camp also contains a blacksmith shop, a repair shop, offices for the contractor, and offices for the engineers, as well as stables, etc. This camp utilizes an old farm property, with the office in the farmhouse, and the barn available for teams and feed.

Those Responsible.—The work is be-

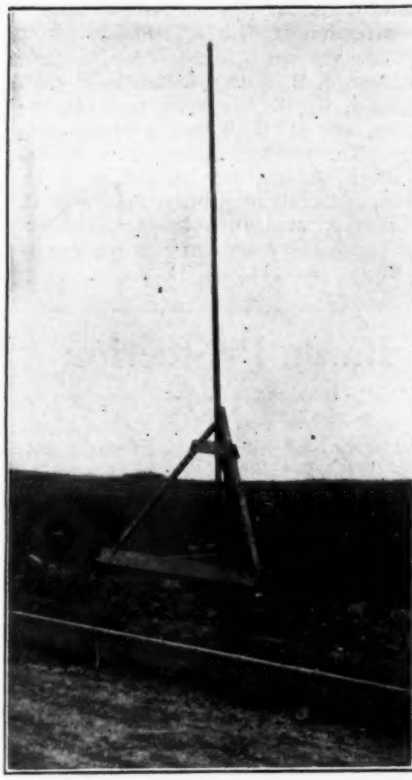


Fig. 7.—This Fitting on the Water Line was Used to Stabilize Pressures

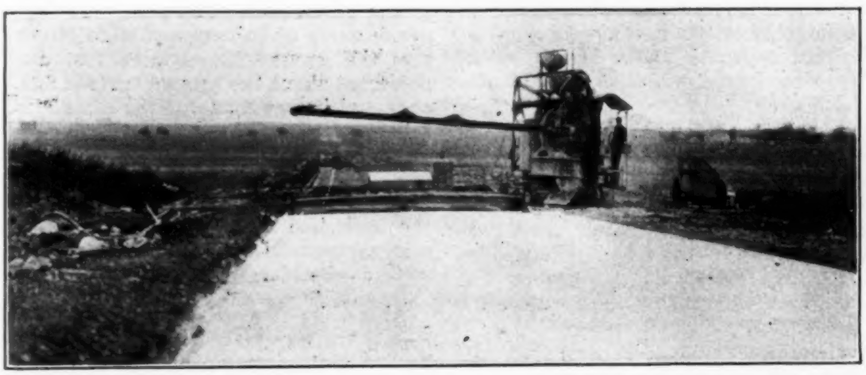


Fig. 8.—View at Paver, Showing Machine off Subgrade Being Paved, Looking Toward Grading Equipment. Prepared Subgrade not Disturbed in any Manner Ahead of the Paver

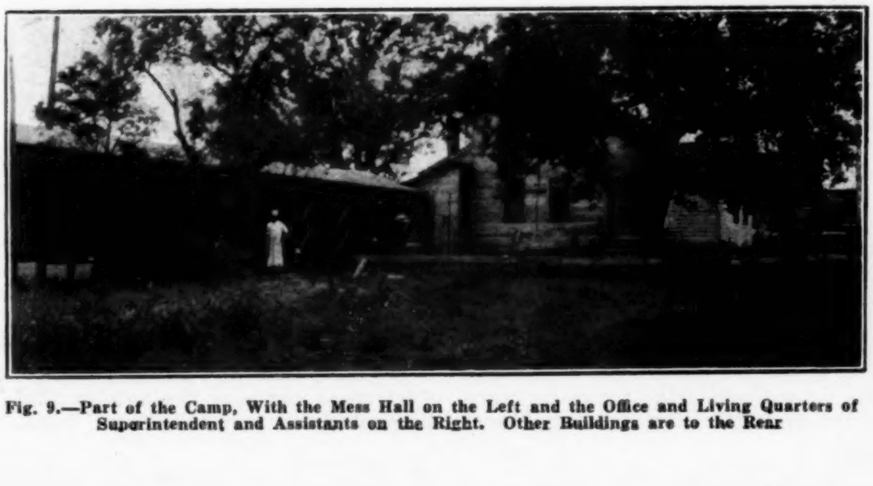


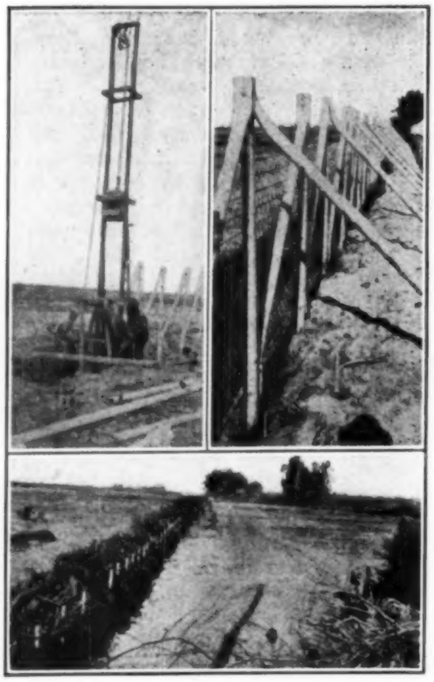
Fig. 9.—Part of the Camp, With the Mess Hall on the Left and the Office and Living Quarters of Superintendent and Assistants on the Right. Other Buildings are to the Rear

ing done for the State of Illinois under the direction of Frank T. Sheets, chief highway engineer, G. N. Lamb, district engineer, J. H. Miller, assistant district engineer, K. D. Avedesin, resident engineer, and R. H. Tittle, project engineer. The work is being done by W. A. Black, & Co., represented by J. H. Airey, general superintendent, and C. E. Heaps, superintendent in charge. The commissary company is represented at the work by C. H. Lang.

Bank Protection Work

Methods and Cost of California Job

THE Division of Highways of the California Department of Public Works has recently completed an interesting bank protection job along the last bank of the Santa Ana River at the state highway Chapman Ave. bridge in Orange County. The work which called for the construction of 2,000 lin. ft. of revetment is described in the May-June issue of California Highways and Public Works.



Top Views: Pile Driver and Fence; Bottom View: Completed Revetment

Flood waters of February, 1927, cut out a large area of land along the east side of the river channel just north of the state highway bridge and inundated the highway for about a mile, closing the road to traffic for nearly a day, and flooded residences and places of business. Serious cutting occurred at the east approach to the bridge, where the embankment was menaced for several hours.

A timber pile and wire revetment, constructed by local interests, which extended along the east river bank from the bridge abutment 2,000 ft. upstream to a grove of eucalyptus trees was washed away by the flood. The wooden piling had rotted at the ground line and was broken off by the force of the flood water.

As it was necessary to replace the revetment which had been washed away, in order to safeguard the state highway bridge and prevent the recurrence of the flooding of the highway as well as private property along the east bank of the river, a plan was proposed by District Engineer S. V. Cortelyou which was accepted by the Olive and West Orange Protection District, in whose territory the flooded area was located. The cost of the work was shared equally by the state and the protection district.

Construction Methods.—Work consisted of the construction of 2,000 lin. ft. of double fence of pipe posts and woven wire and brush bank protection. In addition to the 2,000-ft. line, two 50-ft. wing offsets were constructed at the upstream end to serve as a second line of defense against the entrance of the stream behind the protection work.

The protection work was constructed along a straight line extending from a point 2,000 ft. upstream to the east abutment of the Chapman Ave. highway bridge. Posts, which were spaced 6 ft. on centers both longitudinally and transversely, consisted of 3¼-in. O. D. tubing galvanized. The posts were approximately 20 ft. long and were driven into the ground 13 or more feet and projected above the ground surface 6 ft. Diagonal braces made of the same size tubing were placed on the front line or river side in each panel, and were used on each alternate panel transversely from the front line of posts to the back line of posts, affording rigid construction. Galvanized ⅝-in. bolts were used to fasten the braces in place.

Along the row of posts on the river side there was placed 8 ft. of Ellwood Type "I" fencing, which was composed of two 58-in. widths of the fencing, which were lapped 20 in. at the ground line, where the wear is the greatest. The upper width of fencing came to within 18 in. of the top of the posts and extended 4 in. below the ground surface, while the lower width of fencing extended 42 in. below the ground surface.

One 58-in. width of Ellwood Type "I" fencing was fastened along the back row of posts and extended 10 in. below the ground surface, with 4 ft. above the surface. This type of fencing has a 2-in. mesh and is woven with two-strand No. 12½ cables and No. 14 cross wires. The fencing was stretched tight and securely fastened to the pipe posts with tie wire.

When all fence wire was in place, the 6-ft. space between the two parallel lines of fence was filled with brush, walnut tree limbs and rock to weight it down.

At the upstream end of the 2,000 lin. ft. of protection work, two wings each 50 ft. long and constructed at an angle to the 2,000-ft. line ran back into the river bank and into a grove of eucalyptus trees. The wings were constructed the same as the main line of protection work, one being placed at the end of the protection work and the second 80 ft. back from the end.

Costs.—The costs of constructing the bank protection work per lineal foot is as follows:

	Per Lin. Ft.
Labor (equipment, supplies, etc.):	
Setting posts and braces	$0.546
Stretching fence fabric	0.099
Cutting brush, hauling and placing	0.412
Excavate to let fabric into ground and remove trash and old concrete encountered	0.328
Materials:	
3¼-in. O. D. galvanized posts and braces on job	2.124
Fence fabric, delivered to job	0.353
Tie wire	0.004
Bolts	0.037
Total cost per lineal foot	$3.903

The average cost of driving the 712 posts 13 or more ft. into the ground was $1.44 each, while the average cost of fitting and bolting the braces in place was 22 ct. each.

Bidders on Public Work in New Jersey Must Show Qualifications

The governor of New Jersey has signed Assembly Bill 219 which grants permission to any officer, board, commission, or department, or other branch of State Government to require the filing of a questionnaire on the part of any bidder who desires to bid on public work and to reject bids received from those not qualifying.

The provisions of this act given herewith are as follows:

1. It shall be unlawful for any officer, board, commission, committee, or department, or other branch of the State Government to require from any person proposing to bid on public work duly advertised, a standard form of questionnaire and financial statement containing a complete statement of the person's financial ability and experience in performing public work, before furnishing such person with plans and specifications for the proposed public work advertised.

2. Whenever such officer, board, commission, committee, or department, or other branch of the State Government is not satisfied with the sufficiency of the answers contained in such standard questionnaire and financial statement of such person, it may refuse to furnish such person with plans and specifications on public work duly advertised and the bid of any person to whom plans and specifications have not been issued may be disregarded.

3. The word "person" as used herein shall mean and include any individual, co-partnership, association, corporation or joint stock company, their lessees, trustees, or receivers appointed by any court whatsoever.

4. No action of any nature or description out of any court of competent jurisdiction shall lie against any officer, board, commission, committee, department or other branch of the State Government because of such refusal to furnish such person with plans and specifications on public work duly advertised.

5. All acts and parts of acts inconsistent with the provisions of the act are hereby repealed and this act shall take effect immediately.

Determination of Proportions of Constituents in Concrete

Method of Analysis Discussed in Public Roads

By L. G. CARMICK

Associate Chemist, Division of Tests, U. S. Bureau of Public Roads

THERE are many occasions when it is of considerable importance to know the relative proportions of cement, sand, and stone that were used in the building of some concrete structure. If concrete proves good, we want to know why it is good, and if it is bad our first thought is usually a question as to the proportions used in making it. In practically every laboratory where engineering materials are tested samples of concrete are sent in from time to time and the chemist is asked to determine their proportions. Many of these cases have a legal aspect in that the concrete is suspected of being other than as it should be. Perhaps the contractor is accused of skimping the mix. In such cases a dependable analysis is of the highest importance.

Analysis Difficult.—At first thought it appeads rather a simple matter to make such an analysis, but actually it is very difficult. This is true notwithstanding the fact that considerable work has been done on the problem in a number of good laboratories.

The difficulties involved are of several sorts. In the first place there is apt to be considerable segregation even in well-mixed concrete and a small sample can not be considered as representative of a large mass. When we endeavor to avoid this error by taking a large number of samples we are met by difficulties in the analysis itself and the lack of an entirely satisfactory method. The cement, sand, and stone are all composed of about the same constituents—silica, alumina, and lime, together with some others that are present in lesser amount. The proportions differ in the different materials, and while it is easy enough to tell how much lime the concrete contains it is not easy to say how much of it is from the cement and how much from the sand or stone.

Bulletin 61 of the Iowa State College, Estimation of the Constituents of Portland Cement Concrete, by George W. Burke, offers a method that appeared to be highly promising, and the work reported in this paper has been an effort to determine the degree of accuracy which can be secured with it.

Method of Analysis.—Briefly, the method is as follows: A sample of the concrete, weighing from 1,000 to 1,500 grams, is broken into fragments of not more than 2 in. in size and heated in a muffled furnace for about three hours at a temperature of 600 to 700° C. This causes dehydration of the set cement and should make it easy to separate and clean the coarse aggregate by scraping or brushing. All material below ¼ in. in size is called "sand-cement mixture." A sample of this is put aside for analysis and from the remainder an effort is made to secure a representative sample of the sand. This is done by sifting and rubbing in a mortar with a rubber-covered pestle. The process is described in detail in the bulletin. The sand-cement and the pure sand thus obtained are each analyzed for silica and for lime. A calculation can then be made of the proportions in the sand-cement mixture with either of these data and assuming the percentage of lime or silica in the cement.

For example, representing the proportional weight of the cement present by C and the proportional weight of the sand by S, a unit weight of the mixture can be expressed by

$$C+S=1 \qquad (1)$$

Knowing the lime content of the cement, sand, and sand-cement mixture we can write

$$P_cC+P_sS=P_m(C+S) \qquad (2)$$

in which P_c=per cent CaO in the cement,

P_s =per cent CaO in the sand,

P_m=per cent CaO in the sand-cement mixture.

Solving equations 1 and 2 simultaneously, the values of C and S may be calculated. In the same way calculations may be made on the basis of the silicia content of the materials. In using this method when a sample of the original cement is not available it is necessary to assume an analysis for it. Twenty-one per cent silica and 62 per cent lime are considered as about average.

Preliminary experiments, made by the Bureau of Public Roads but not given in detail here, have shown that when the coarse aggregate is limestone or dolomite the results obtained by this method are very uncertain. Baking the sample at 600° to 700° C. partially calcines most limestones, and if a lower temperature is used it is hard to disintegrate the concrete. Many small fragments of the limestone are sure to be included with the sand-cement mixture and seriously impair the accuracy of the results. Some other stones, such as granites which are not thoroughly sound, are easily broken down after heating.

To obtain even approximately correct results by this method it appears to be necessary that the coarse aggregate be a rock that is not much affected by the heat used, not easily crumbled, and noncalcareous, and also that the sand be noncalcareous and not much affected by dilute hydrochloric acid.

Test of the Method.—As a test of the method, 10 small cylinders were made of a mortar consisting of 1 part cement and 2½ parts Potomac sand which meets the above conditions. These cylinders were analyzed and the results are given in Table I. The first three cylinders were treated exactly in accordance with Burke's dry method. All of the sand from cylinders Nos. 4, 5, 6, and 7 were washed with a 5 per cent solution of hydrochloric acid and the sands from cylinders Nos. 8, 9, and 10 were washed with water. It seems evident that it is necessary to wash the sand with acid, as otherwise it carries with it a considerable amount of cement. It is apparent also that a much greater degree of accuracy is obtained by using the true lime content of the cement (59.60 per cent) instead of an assumed value of 62 per cent. Calculations made on the basis of the silica content were so wide of the mark that they are not given.

Believing it possible to improve on the above results by greater care and attention to detail, another set of 12 cylinders was made from the same cement and sand, using a 1 to 2 mix.

The sands from the first four were brushed dry, those from the next four were washed with a 5 per cent hydrochloric acid solution, and those from the last four were washed with water. The greatest care was taken in the preparation of the samples and in the analyses. The results are given in Table II and show a considerable improvement in accuracy. It was again apparent that it is necessary to wash the sand with acid and to know the true lime content of the cement. This series also showed that the silica content is far less reliable as a basis for calculations.

It is believed that this second series shows the maximum degree of accuracy that can be hoped for in case of mortars when the conditions and materials are almost ideal.

Continuing the investigation, 10 con-

Table I—Test Results of Analysis of Cylinders Made With 1 Part Cement and 2.5 Parts Potomac Sand

ANALYSIS OF MATERIALS

Per cent	Sand	Cement	Sand and cement mix (theoretical)
SiO_2	89.90	20.80	70.16
CaO	.50	59.60	17.39

ANALYSIS OF MORTAR CYLINDERS

Cylinder No.	Sand and cement: SiO_2	Sand and cement: CaO	Sand: SiO_2	Sand: CaO	Cement to sand, parts: Based on true lime content of cement	Cement to sand, parts: Lime content of cement assumed as 62 per cent	Remarks
	Per cent	Per cent	Per cent	Per cent			
1	70.44	16.23	91.38	1.54	1 : 2.95	1 : 3.11	Sand brushed dry.
2	70.75	16.55	87.80	3.34	1 : 3.25	1 : 3.42	
3	70.40	17.22	88.56	2.74	1 : 2.92	1 : 3.10	
4	70.72	16.69	95.14	.30	1 : 2.60	1 : 2.78	Sand washed with dilute HCl (5 per cent).
5	71.82	15.90	94.73	.13	1 : 2.77	1 : 2.92	
6	70.31	16.85	94.55	.34	1 : 2.57	1 : 2.71	
7	70.21	17.08	94.00	.34	1 : 2.53	1 : 2.69	
8	70.87	16.41	90.17	2.50	1 : 3.10	1 : 3.27	Sand washed with water.
9	71.40	16.13	92.18	1.97	1 : 3.06	1 : 3.23	
10	71.17	16.40	91.20	2.23	1 : 3.06	1 : 3.22	

Table II—Test Results of Analysis of Cylinders Made With 1 Part Cement and 2 Parts Potomac Sand

ANALYSIS OF MATERIALS

Per cent	Sand	Cement	Sand and cement mix (theoretical)
SiO_2	89.90	20.80	66.87
CaO	.50	59.60	20.20

ANALYSIS OF MORTAR CYLINDERS

Cylinder No.	Sand and cement: SiO_2	Sand and cement: CaO	Sand: SiO_2	Sand: CaO	Cement to sand, parts: Based on true lime content of cement	Cement to sand, parts: Lime content of cement assumed as 62 per cent	Remarks
	Per cent	Per cent	Per cent	Per cent			
1	67.15	20.00	88.40	1.45	1 : 2.13	1 : 2.26	Sand brushed dry.
2	67.25	19.80	88.70	1.65	1 : 2.19	1 : 2.32	
3	67.20	19.85	89.00	1.55	1 : 2.17	1 : 2.30	
4	66.50	20.40	88.65	1.50	1 : 2.07	1 : 2.20	
5	66.95	20.10	94.25	.30	1 : 2.00	1 : 2.11	Sand washed with dilute HCl (5 per cent).
6	66.45	20.45	95.10	.20	1 : 1.93	1 : 2.03	
7	67.15	19.95	92.85	.25	1 : 2.01	1 : 2.13	
8	67.10	19.85	93.20	.20	1 : 2.02	1 : 2.15	
9	66.90	20.20	88.15	1.40	1 : 2.10	1 : 2.22	Sand washed with water.
10	67.00	20.25	88.65	1.45	1 : 2.09	1 : 2.22	
11	67.00	20.35	89.10	1.35	1 : 2.07	1 : 2.19	
12	66.55	20.05	88.55	1.80	1 : 2.13	1 : 2.26	

Table III—Test Results of Analysis of Cylinders Made With 1 Part Cement, 2 Parts Potomac Sand and 4 Parts Gravel

ANALYSIS OF MATERIALS

Per cent	Sand	Cement	Sand and cement (theoretical)
SiO_2	89.90	21.15	66.98
CaO	.50	61.10	20.70

ANALYSIS OF CYLINDERS

Cylinder No.	Weight of sample (grams)	Weight of stone (grams)	Weight of sand (grams)	Weight of cement (grams)	Sand and cement: SiO_2	Sand and cement: CaO	Sand: SiO_2	Sand: CaO	Proportions found	Remarks
					Per ct	Per ct	Per ct	Per ct		
1	1,040	575	321	144	67.20	20.15	90.90	1.85	1:2.23:4.00	Sand brushed dry.
2	1,115	660	319	136	66.15	19.85	91.45	2.15	1:2.34:4.85	
3	1,280	740	366	154	65.70	19.75	88.70	2.30	1:2.37:4.80	
4	1,075	635	295	145	65.95	20.40	93.15	.35	1:2.03:4.38	Sand washed with HCl (5 per cent).
5	1,210	680	357	173	66.05	20.10	92.75	.20	1:2.06:3.93	
6	1,315	760	367	188	67.73	20.75	93.25	.20	1:1.95:4.04	
7	1,175	635	355	185	66.45	21.05	93.40	.15	1:1.90:3.43	
8	1,275	734	386	157	67.10	21.10	90.85	2.20	1:2.12:4.66	Sand washed with water.
9	1,085	610	333	142	66.25	19.90	89.10	1.85	1:2.34:4.30	
10	1,145	640	346	150	66.60	20.35	90.15	1.70	1:2.17:4.07	

crete cylinders were cast, using the same sand but a different cement, and a 1:2:4 mix. The coarse aggregate consisted of clean siliceous pebbles 1 in. or less in size. The test results are given in Table III. Again a great improvement is noted in those cases where acid washing was resorted to.

Conclusions.—The following conclusions are drawn from these experiments:

(1) It is of the utmost importance to have samples of the original constituent materials used in making the concrete. It is particularly neecssary to know the true CaO content of the cement, as actual variation from an assumed value may introduce a considerable error.

(2) Calculations should be made on the basis of the CaO content of the cement. Those made on the basis of silica content are not at all reliable.

(3) Reasonable accuracy can not be secured unless the fine aggregate is siliceous and little affected by dilute hydrochloric acid, and the coarse aggregate a noncalcareous rock which will not be broken down by the necessary heating.

(4) Washing the whole of the sand with dilute hydrochloric acid secures greatly increased accuracy.

(5) The best results which can be obtained by this method are only approximate, since—

(a) Results having a high degree of accuracy can not always be obtained by the analyses of samples of known composition; and,

(b) Small samples of concrete such as would be used in this method may not be truly representative of the mass from which they were taken.

(6) The limitations which have been pointed out and the lack of accuracy under highly favorably conditions show that this method is of practical value only when approximate rather than exact information is desired.

Grade Crossing Accidents in Wisconsin

The following interesting information regarding accidents at steam railroad grade crossings is taken from the fourth quarterly report for 1927 of H. J. Kuelling, State Highway Engineer of Wisconsin:

A detailed field checkup has been made of all crossing accidents reported to the commission, and result of a study of this information for the last six months is given below.

Summary of Steam Railroad Grade Crossing Accidents
(as reported in press)
July 1—December 31, 1927

	Half Year Total
Total accidents	165
Passenger train	79
Freight train	49
Switch train or engine	37
Passenger auto	130
Truck	32
Horsedrawn vehicle	3
On state trunk highway	50
Maintained detour	4
On connecting street	17
County trunk	10
City or village street	64
Town road	16
Private crossing	5
Train struck vehicle	112
Vehicle struck train	52
Obstructions prevented turn to right or left	32
Clear vision crossing	70
Protected crossing	58
Persons killed	36
Persons injured	148

These data are based very largely upon information secured from the press and consequently there are probably many omissions. Field investigation of each accident was made when possible and additional data secured. Through the cooperation of the Railroad Commission to whom all accidents are reported by the railroad companies in compliance with the law it will be possible during the coming year to check up on practically every accident.

The information at hand brings out several important points of interest. 54 of the accidents or 33 per cent of the total occurred on the state trunk highway system or on maintained detours. When the 17 that occurred on the connecting streets are added the total of 71 indicates that 43 per cent were on the marked and numbered routes that concentrate a large amount of motor traffic on 10,000 of the 71,000 miles of highway in the state and consequently on a very small percentage of the total grade crossings. 64 accidents or 39 per cent were on city and village crossings other than on connecting streets of which there are several thousand in the state many of which have poor vision, good pavement, no protection and high speed trains. There were only 16 accidents on the town roads. It is frequently argued that with the many thousands of town road crossings that it is not necessary to eliminate a comparatively few crossings on the main roads but these data would seem to indicate a very large percentage of the accidents outside of the cities and villages come on the state trunk highway crossings.

It would be expected that the number of accidents would decrease during the winter but as a matter of fact there is an increase both in the country and in the cities and villages.

The above table shows that 58 or 35 per cent of the accidents occurred on crossing protected with gates, watchmen, or automatic signals. This should not be accepted as an indictment of crossing protection as in many cases the watchmen were not on duty. Intermittent crossing protection gives a false sense of security and there is a pronounced tendency toward the replacement of this type of protection with automatic wig-wags that are operated by the approaching train.

While the information is not complete it should be noted that 32 of the 165 accidents might have been averted if it had been possible for the driver of the car to turn to the right or left. The commission is inaugurating a campaign to improve safety conditions at grade crossings by securing the removal of telephone poles, guard fence, culvert and walls, banks of earth and other obstructions at the sides of the road adjacent to the track and it is believed that during the next year considerable progress will be made.

The Writing of Highway Specifications From the Contractors Viewpoint

Paper at 1928 Highway Conference at U. of Colorado

By HENRY M. ROBERTS
Of the J. Fred Roberts Construction Co., Denver, Colo.

HIGHWAY specifications and the writing of highway specifications are matters of the greatest possible interest to the writer. Why shouldn't they be? He makes his living solely by carrying out the provisions of engineering specifications. His daily contact with them is so close that it behooves him to be as familiar with them as is the average field engineer under whom he works. He must be familiar not only with the written word, but familiar also with the customary application of the written word to the job of producing a workmanlike and acceptable finished project. The inducement which impels the speaker to familiarity is even greater than is the engineer's. Ignorance on the speaker's part will probably affect his pocketbook more directly and more extensively than would equal ignorance affect the engineer's.

The writer believes that it is frequently true that at the time of moving onto a highway project he is more familiar with the specifications than the resident engineer under whom he is to work. He must be familiar with the specifications in order to make an intelligent bid. If the engineer is familiar with the details and possible innovations in the specifications by the time the contractor is ready to start operations, that is usually soon enough.

A tirade might be launched against the acknowledged onesidedness of all engineering contracts and specifications and anathemas might be heaped upon all connected with the writing of such specifications. Concrete examples might be presented in considerable detail of what may be called the airtightness of the present-day highway specifications in safeguarding the interests of the state and delivering the contractor bound and gagged into its hands. Procedure along this line, however, would probably bring out nothing that is not already familiar to most of you. A layman, unfamiliar with engineering contracts and specifications, might possibly feel that an excellent case had been made and that any contractor who signed such a contract and bound himself by such onesided specifications was indeed placing himself in a particularly defenseless position. On the other hand, it would be easy for any of you to dispose of this elaborately built-up case by simply calling to mind the fact that in this country every year literally billions of dollars' worth of work is done and brought to successful and peaceful conclusion under specifications substantially identical in airtightness and onesidedness with those which were being attacked.

Certainly, if the proof of the pudding is in the eating, the present essentially standardized form of contract and specification has justified itself by virtue of its widely extended and successful application.

Study of Existing Specifications.—It is true that probably at no time in the past have specifications been given the close attention, with the object of improvement, that they have received in the past two or three years.

About three years ago, the Colorado Highway Department undertook a rather extensive revision of all its highway specifications. The task was taken up in a very thorough manner. Contractors were invited to co-operate by expressing their views on the old specifications and making suggestions for improvements in the new ones. A number of conferences were held for this purpose. The amount of time allowed the contractors to fully state their case was most pleasing. Pleasing also to the contractors were the new specifications when they appeared carrying, as they did, many changes which reflected the contractors' viewpoint.

It is understood that at about the same time, New Mexico felt that some changes were in order and that these changes were generally considered a distinct advance from the contractors' viewpoint.

At the present time, Colorado specifications seem to be undergoing more or less constant scrutiny and modification. The requirements covering the matter of the driving of precast concrete piles have been subject to several radical changes since the use of such piles was started about three years ago. Also, of the last three contracts awarded to the speaker's firm, no two have been alike in the minor manner of just how creosote should be applied to the posts in the guard fence.

Last summer, Colorado made a radical change in its concrete paving specification by discarding the fixed ratio of 1:2:3 and adopting the recently developed water-cement ratio specification. Colorado jumped in at the deep end of this question and went so fast that limiting ratios between fine and coarse aggregate were forgotten. When the first job was advertised, nothing in the specifications could be found which would prevent using 10 parts of sand to 1 part of rock provided the stipulated ratio between water and cement was maintained. No more than 5½ parts of total aggregate to 1 part of cement was used, and a product of the required compressive strength and one that was both workable and dense was obtained. This was water-cement ratio with a vengeance.

The next specifications which were issued carried a clause stating limiting ratios between fine and coarse aggregates.

As an interested spectator, the writer is inclined to believe that the water must have been too chilly for comfort, because Colorado popped out again just as quickly as it popped in. Specifications which have come out in the last 30 days show clearly that while the form of a water-cement ratio is still there, the substance is gone. We are back on the firm foundation of a 1:2:3 mix and now have all the disadvantages of the water-cement ratio and none of its advantages. This is brought about in a very simple manner by placing such limits on the ratio of total aggregates to cement and such limits on the ratio of coarse aggregate to fine aggregate that the most economical mix possible is a 1:2:3 mix.

Contractor's Viewpoint Is Different From Engineer's Viewpoint.—Reference is made to this matter without any idea of criticism, but for the reason that it leads to one of the "viewpoints" that the speaker desires to bring out. From a strictly contracting viewpoint he doesn't care very much whether the specification calls for unrestricted water-cement ratio, a 1:2:3 mix, or a 1:5:10 mix. These things fall within the engineering aspect of the specification. The contractor is only subordinately interested in this aspect. Let the engineer design the work and the contractor will build it. Let the engineer state the conditions and it becomes the job of the contractor to reflect the conditions as they affect the cost of doing the work.

It costs the contractor more to meet one specification than the other. In the long run, as a matter of course, the contractor will pass the added cost on to the party of the first part. He wouldn't survive if he did not do this.

Conversely, it is believed that the prices submitted on the few projects where a true water-cement ratio was approximated showed conclusively that the contractors immediately discounted the reduction in cost permitted by the specification and promptly passed the saving on to the state. Competition always did and probably always will accomplish this result.

What then is the contractor interested in, if it is not in the engineering aspect of the specifications? He is most vitally interested in two things—"clearness" and another attribute which cannot be described in one word.

Clearness Is Essential.—Above all things, clearness of statement of the conditions and intent of our specifications is required. The fundamental legal conception of a contract is that it represents a meeting of the minds of the contracting parties. Specifications should possess such clearness of statement of intent and such freedom from ambiguity that, as far as is humanly possible, a meeting of the minds is achieved. If a reasonable meeting of the minds is not achieved when the contract is signed, the contractor is likely to be the chief sufferer later on. It is desirable that there should be a meeting of the minds not only as to the written word, but also a mutual understanding, as far as possible as to the equitable interpretation of the written word when applied to the job of producing an acceptable completed project. Such a mutual understanding as to interpretation can probably come only as a result of extended experiences on the part of both parties. The possibility of a lack of such mutual understanding as to interpretation constitutes one of the major hazards in what is usually considered a rather hazardous calling. May specifications be so clear as to be self-explanatory except when applied to unlooked-for conditions and may they then be interpreted with full regard to the proper best interests of both parties.

Adequately Diversified Unit Classification of Quantities.—Now to pass on to that attribute of specifications which the speaker is unable to name and perhaps may be unable to definite adequately. It can be illustrated more clearly and adequately than it can be defined. Colorado highway specifications up to a few years ago, contained no mention of "structure excavation." There was no such item on the proposal sheets. The contractor submitted a cubic-yard price on structure concrete, complete in place and figured into this price as best he might the probable cost of the required footing excavation. Whether later developments showed that his judgment as to probable cost was good or bad, he absorbed the actual cost and was paid only on the basis of cubic yards of concrete in place.

Colorado specifications today provide for the offering of proposals not only on concrete, but on dry common structure excavation, wet common structure excavation, dry rock structure excavation, and wet rock structure excavation. The contractor is paid substantially in proportion to the difficulties he meets and in proportion to the expense he undergoes. An avoidable element of hazard has been practically eliminated. Present specifications contain an attribute that former specifications lacked. The best the writer can do is to define it as "adequately diversified unit classification of quantities." It is an attribute most earnestly and fervently to be desired. It is an attribute which, when developed to its fullest extent, does more than anything else to remove the element of hazard from the construction industry. Perhaps there are a few contractors so confident of their superior judgment, experience, and ability to size up a job that they would prefer the gamble of the unclassified proposal. The speaker feels that they are greatly in the minority. He feels also that the same contractor who would be willing to gamble on his judgment of structure excavation would frequently be glad to avail himself of a diversified classification on some other type of work on which he did not feel quite so sure of himself.

Reference has been made to the extensive renovation of specifications which took place in Colorado three years ago. The writer believes that almost without exception, the changes advocated by the contractors tended toward greater clearness in the specification or a more diversified classification of unit quantities. If this is true, perhaps it is the best evidence that could be offered that this paper voices not only the writer's viewpoint, but perhaps to some limited extent, the viewpoint of contractors as a class.

During the conferences which were held no contractor ventured to suggest to our highway department that the mixing proportions of concrete pavement should be changed to 1:2¼:3¼ because such a mixture would cost a little less per square yard. Of course, not! Such a question pertains to the engineering aspect and is of minor interest to the contractor.

Recall a very few of the many changes that were made at that time. Classified structure excavation was introduced. Overhaul was specified on borrow excavation and on gravel surfacing material. The free haul limit in figuring overhaul was reduced from 800 to 300 ft. Every one of these changes was advocated by the contractors. Every one of them tended to reduce the hazard. Every one of them looked toward the goal of diversified unit classification of the work to be done. Every one had the effect of reimbursing the contractor more nearly in proportion to the expense undergone in doing the work. Even the reduction of the free haul limit helped to draw a line of demarkation between the job having an average haul of 600 or 700 ft. and the side-borrow fresno job, and to pay the contractor accordingly.

All these changes indicate an increasing tendency to reimburse the contractor in proportion to the expense he actually undergoes in doing the work. Likewise they indicate a decreasing tendency toward paying him in proportion to the expense he thinks he will undergo before he starts the work.

This is probably the most fruitful yield of any for future improvement of specifications from the contractor's viewpoint and it is respectfully commended to your attention.

Happily, the writer is in a position to commend it as being just as desirable from the standpoint of the state as it is from the standpoint of the contractor. It is not good business for the state to profit at the expense of the contractor when the latter must carry on at a loss because of unforeseen difficulties and expense that may arise during the progress of construction operations. Neither is it good business for the state to pay an excessive price on operations where reasonably possible difficulties and expense did not actually materialize in the doing of the work.

Responsibility of the Engineer.—At the beginning of this paper the writer stated that he was much interested in the writing of specifications. He is just as much interested in what is implied in specifications as he is interested in what is written in them. Glance through the typical contract and accompanying specifications. They are sprinkled throughout with paragraphs delegating responsibility to the contractor and conferring authority to the engineer over the contractor and over the contractor's movements and actions. Viewed strictly in this light, it would appear that the agreement has given practically all the responsibility to the contractor and all of the authority to the engineer. This is an impossibility, legally, normally, and practically. No valid agreement of the magnitude and complexity of a highway contract can place all of the authority on one side and all the responsibility on the other. How, then, is a more even balance to be attained? In this way—very little is written in our specifications about the responsibility of the engineer, but that responsibility is everywhere implied.

Sir Isaac Newton said that action and reaction are equal. He made this statement at the conclusion of some motion studies that were made many years ago—long before the Division of Management, Bureau of Public Roads, started its particular kind of motion studies in attempting to determine the capacity of a ¾ yd. steam shovel. If a man is given wide authority he is given, at the same time, an equal burden of responsibility. Responsibility to whom? Responsibility to the one over

whom he has the authority, of course.

Every time the engineer inserts a clause in the specifications widening his authority over the contractor, he increases his responsibility to the contractor just that much.

Frequently paragraphs start in this way: "When in the judgment of the engineer" . . . and frequently they end like this, "and as to this the engineer shall be the sole judge." Those words have a very judicial sound. In truth, our specifications confer on the engineer very considerable judicial authority, and with this authority is conferred an equal judicial responsibility. The judge on the bench is given by law very wide authority over the prisoner before him. He can give the prisoner one year or ten years, or throw out the case for lack of evidence. He is in the pay of the state and not in the pay of the prisoner. He probably does not like the prisoner personally. Does he let any of these facts influence him an iota in placing the proper legal rights of the state above the proper legal rights of the prisoner? He does not. His judicial responsibility will not permit it. He never saw the prisoner before, but the judge has a tremendous responsibility to him simply because he has been given great authority over the prisoner.

The writer is happy to be able truthfully to say to this gathering that it is his belief that, in general, the engineering profession accepts its implied judicial responsibility to the contractor in a most creditable and satisfactory manner, although there have been isolated and infrequent cases when he has felt that the impartial standard of the supreme bench has not been quite achieved.

Summary.—The writer wishes to repeat at this point that he is very much interested in that which the specifications imply.

To sum up, give the contractor three things:

First—Specifications that are clear.

Second—Adequately diversified unit classification of quantities.

Third (and most important)—An engineering turn of mind that recognizes and accepts to the fullest proper extent, its large implied judicial responsibility to the contractor.

Give contractors these three things and most of them will be very happy to continue to sign lop-sided contracts for the rest of their lives.

As a Banker Sees the Civil Engineer

The May Proceedings of the American Society of Civil Engineers contains an open letter from Mr. William L. De Bost, president of the Union Dime Savings Bank and of the Chamber of Commerce of the State of New York, which is of so much general interest to the profession that we are reprinting it below.

"Dear Mr. ....:

"You have asked me to put into the form of a letter the remarks which I made to you as we sat beside each other at a public dinner recently, when I told you the impression I had of engineers, more particularly, civil engineers.

"To express those ideas, as to the engineering profession, in a form, which as you suggest, may be put into type, makes me conscious of appearing to make statements about things that I can easily be accused of knowing little. However, I have for some time had a rather definite impression about civil engineers and I am willing to give you my thoughts, even though I may seem to be rather blunt in doing so.

"I wonder if you civil engineers are not making a great mistake in fostering what I consider an inferiority complex. I think, if you analyze yourselves, you would say that you have just the reverse, that you have a superiority complex. You are pridefully conscious of being very honest minded in your work and in your deportment. That I heartily agree with, but as a direct result of this pride you have built a shell around yourselves and withdrawn into it. You are thus looking at yourselves rather than at life as it is and, in my judgment, are herefore suffering from self-effacement.

"Perhaps I have tried to say too much all at once. What I mean is that your work alone will not do all the speaking for you. I believe you should identify your persons with your work. Air is a benefit, but people pay nothing for it. Good pavements are a benefit, but they have become almost as common as air, and you who spend your lives trying to devise better sreets are taken as a matter of course, and are practically unknown, except to a fairly small circle.

"That is the result of your being viewed just as you have wanted to be —capable, essential, dependable. But so dependable are you that no further thought need be taken of you. Come what may, the engineers can be depended upon. Why bother further? Let's think of something else.

"Now that is not the way the business world functions today. It does not say, 'I know this is good; let others think of it as they may.' It says, 'This idea, though good, must be presented to others so that they also will know that it is good.'

"Why are you so modest? Why don't you try to make yourselves noticed and known as others do? Why don't you recognize that people nowadays work —and work hard—to sell their wares? Why assume that your wares will sell themselves? Nothing sells itself without publicity. Even Tiffany advertises.

"You will say that it is not dignified to advertise yourselves, that it is not ethical, and you will point to the doctor, saying that he does not display his wares. I think he does, in a very systematic though indirect way, and that you might do well to copy his method. He makes as presentable a personal appearance as possible. He joins clubs of all sorts. He takes part in civic, social and church affairs. He lets himself be seen, favorably and often, by his clientele. He makes his personality felt as an alert professional man and so the community cannot escape recognizing and admiring him. Now why shouldn't you engineers do likewise? Mix a little outside of your own professional circle—make more friends, widen your circle of acquaintances and let others know what you are doing as individuals.

"I observe great individuality of thought among you. Inability to agree with each other. In your analytical and honest minds you have an habitual attitude to overcome. That is, you will give support to nothing that is not absolutely correct. Now I admire that trait, but you push it too far. You let some slight imperfection distort your view of a program in its broad measures. Get out of your heads that everything must be perfect before you will have anything to do with it. Cease criticism of each other for unimportant details. Agree on general principles, leaving the elements that may be in doubt to be worked out later as exigencies dictate. Get the habit of working together on general programs.

"But I am getting into deep water in trying to point out specific remedies. That, of course, is your problem—not mine—but I think you are not tackling it. In fact, you are making it worse, I believe, by this studious pose of self-effacement.

"Civil engineers, I know, are excellent technicians and wonderfully trustworthy, but they do not make sufficient effort to control circumstances. They let somebody else do that.

"It is my opinion that the general public does not know what you are doing and some other group gets the credit and most of the money. Why don't you educate the public with respect to the important part you take in the world's work? No foundation can be constructed, no large building erected, no railroad built, no bridge can be made possible without you engineers, but how many names of engineers does the general public really know? Mighty few.

"You asked me for a definite statement along the lines we talked that evening. I had said that engineers did themselves a professional injustice by being so modest, as I have found them, and that has led to your request for this letter. If I have said more than I should, I hope that I will only be accused of trying to help a great profession and because of my high regard for engineers in general and especially for my many friends who are engineers."

WILLIAM L. DE BOST.

Pavement Progress in California

Review of State Highway Construction in 1927

By EARL WITHYCOMBE
Assistant Construction Engineer, State Division of Highways

SMOOTHNESS of the pavements constructed during 1927 maintained the same high standard set by the 1926 construction record. With the use of mechanical means of spreading asphaltic mixtures on one entire project and on portion of another, the average of roughness on this type of pavement was reduced.

Strength of concrete has been materially increased over previous records. The field men have acquired a more thorough understanding of the principal factors contributing to the strength of concrete. The average mixture of this year was a much more plastic and workable mix than during 1926.

Construction Methods.—Finishing of concrete followed the same general method as outlined in the 1926 summary.

During the latter part of 1927 it was decided to adopt the use of marginal steel for the purpose of preventing corner breaks at contraction cracks within the slab panels. Adoption of dowels has minimized the corner breaking at expansion joints.

Standardizing on the provision for ½ in. expansion joints at intervals of 60 ft., with two intermediate transverse weakened plane joints, has broken the slab into 20-ft. panels of 10-ft. width. It is expected that this type of construction will practically eliminate uncontrolled contraction cracking. Such construction is not yet of sufficient age to draw definite conclusions, but early results appear very favorable.

The increased number of joints presented difficulty in construction to secure a smooth riding surface and only through careful supervision and constant vigilance of the resident engineers and their assistants was this roughness kept down to a very slight increase over the previous year's record.

Roads Opened Earlier.—A marked change has been made in the time of opening concrete pavements, which has proven a great convenience to the traveling public. The watering period has been cut to eight days, after which the earth blanket used in curing is removed and the pavement is permitted to dry until opened. During the progress of placing concrete, beams are cast at ½ mile intervals and, after curing, are broken in a portable machine designed at the suggestion of C. S. Pope, Construction Engineer, by C. L. McKesson, Materials and Research Engineer. The time at which the pavement is opened to traffic depends upon the strength developed in the beams.

This procedure has saved the traveling public many thousands of dollars in motor vehicle operating costs in addition to convenience, by permitting the early use of pavements that might otherwise be kept closed for an arbitrary period under ordinary specifications.

No marked change has been made in equipment for this type of construction. Concrete mixers have been universally standardized at a cubic yard capacity, and all other units brought up to this output.

Asphaltic Concrete.—Improved methods of spreading are responsible for the increase in smoothness of asphaltic concrete construction. During the past year and a half, experiments were carried on within the department to eliminate the imperfections resulting from hand spreading. The methods worked out with crude hand and horse-drawn implements were incorporated on one of the mechanical finishers used ordinarily on concrete work, and the machine was tried out on two asphalt concrete projects during 1927.

Where mechanical means of spreading were not available, a marked improvement has been made on hand work by following up with a 5-ft., long-handled lute operated transversely across the uncompressed surface. This method tends to eliminate the sharper irregularities remaining in hand-raking.

On contract 96FC2 in Kern County, three methods of spreading were employed with the following results: 0.9 mile of hand work averaged 24.2 in. of roughness per mile, 4.41 miles of hand work followed by a lute averaged 18.6 in. per mile, and 3.32 miles of machine finish averaged 16.4 in. per mile. It can be said, in support of the machine, that this portion of the work was performed during cold weather and would necessarily be rougher than work performed under more favorable conditions.

On contract 96FC1, again in Kern County, where machine finish was used throughout the average roughness of the entire job was 13.9 in. per mile. On the three miles constructed in summer weather, the average was 12 in. of roughness per mile, while the remainder of the job built in comparatively cold weather, averaged 14.7 in.

After a year of experimenting, the high filler content mixture has been adopted as the standard and all but two of the projects constructed this season were of this type. This mixture is a modification of the original experiments by Abson of Chicago along the same line.

The surface finish accomplished by rolling asphalt coated screenings into the freshly compacted surface, has been adopted as standard California practice. Apparently, the larger the screenings, the better the results, and material passing ½-in. and retained on ¼-in. sieve is now used for this purpose.

Other than the mechanical means of spreading, no radical changes have been made in equipment in use on asphaltic concrete pavement this season.

Results of Laboratory Analyses.—The average compressive strength of pavement concrete this season was 4,508 lb. per square inch, the average for shoulder concrete was 3,494 lb. and the general average of concrete strength for both pavements and shoulders was 4,440 lb. per square inch, an increase of 295 lb. over 1926 construction.

Pavement concrete varied in average strength on individual contracts from 3,740 lb. to 4,944 lb., a total variation of 1,204 lb. The total variation in 1926 was 2,160 lb., indicating that much more uniform results were secured in 1927 construction.

Voids in asphalt concrete pavement mixtures varied from 7.4 to 1.8 per cent as found by relative specific gravity determinations. This density is somewhat lower than the 1926 results and is due, to a large extent, to the high filler content. Experiments have shown that this mix, although more stable than the normal mix, is more difficult to compact.

Field Comparisons.—Roughness of portland cement concrete pavements as determined by the vialog average 7.8 in. per mile, an increase of 0.6 in. over the 1926 record. Considering the fact that in the majority of 1927 projects, the normal amount of joints was trebled, this is an enviable record.

Cement control varied from 0.98 per cent to 5.26 per cent and averaged 1.6 per cent. The general average in 1926 was 1.49 per cent.

The average daily output of pavement concrete for all jobs was 201.8 cu. yd. as compared to 186 cu. yd. in 1926. This increase in daily averages was accomplished with but a slight increase in labor required.

Surface roughness for asphalt concrete for 1927 averaged 22.1 in. per mile, as compared to 24.1 in. in 1926.

Daily output averaged 277.1 tons in 1927 and 270 tons in 1926.

Surface Roughness, All Types.—The average roughness has been consistently decreased since the first year in which measurements were taken. The average of 1924 were 22.2 in. of roughness per mile; in 1925, 18.8 in.; in 1926, 15.0 in.; and in 1927, 14.2 in.

In determining pavement roughness in the past, the Division of Highways has used an instrument known as the "vialog," developed in New York state. Recently, however, the United States Bureau of Public Roads has perfected an instrument called the "Roughometer," and this has been definitely adopted for future work.

Acknowledgment.—The above is reprinted from the May-June California Highways and Public Works, the official journal of the Department of Public Works of California.

The Armstrong Vehicular Tunnel In Pittsburgh

Design, Construction, of Project Connecting Two Important Streets

By JOSEPH G. ARMSTRONG

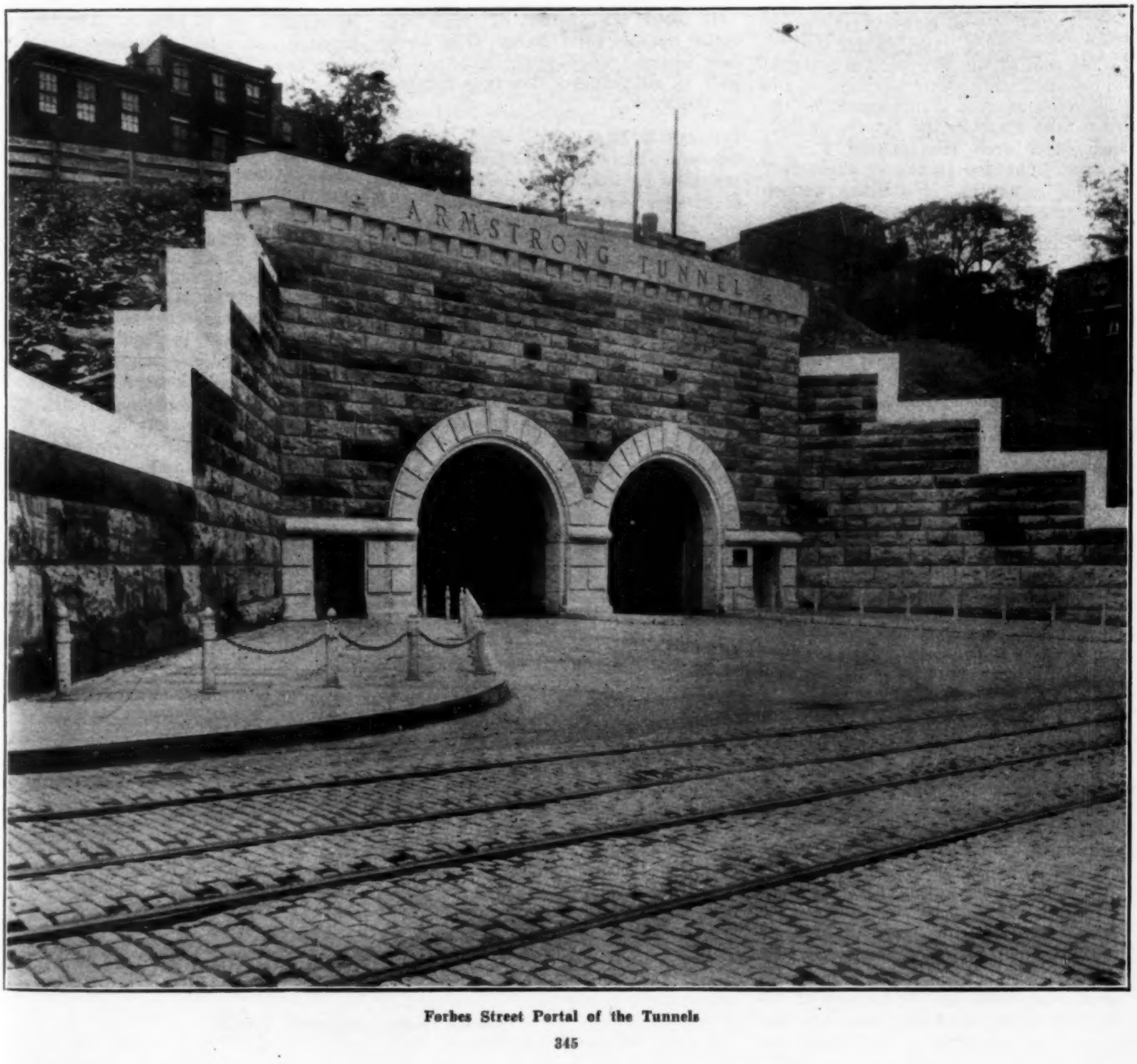
Chairman, Board of County Commissioners of Allegheny County, Pennsylvania

THE Armstrong Vehicular Tunnel connects two of Pittsburgh's busy thoroughfares, Second Avenue and Forbes Street. The tunnel consists of two separate parallel tubes. Before these tubes were built, travel between the two streets was over a rather circuitous route some 4,000 ft. in length. These streets are now directly connected by the 1,300-ft. tunnel, so that the tunnel saves the motorists hours of time as well as thousands of miles of travel each year.

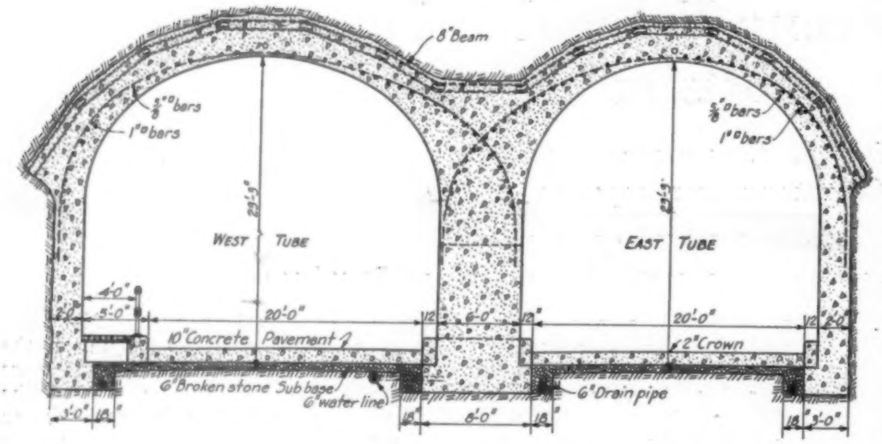
Eleven different alignment studies were made by the engineers of the County Department of Public Works before the final location was decided upon. In the adopted design a curve introduced into the alignment at the Forbes Street end of the tunnel saved the County approximately $320,000 in property damages and eliminated an acute angle intersection at Forbes Street.

The contract for the tunnel was awarded December 16, 1925, and the work started on January, 15, 1926. Tunneling operations were begun on the east tube January 28, 1926, and were completed in six months' time. The header was started in the west tube on June 15, 1926, and all operations were completed October 30, 1926.

Design.—The east tube has a wall-to-wall width of 22 ft. A 4-ft. sidewalk is provided in the west tube, making the wall-to-wall width in this tube 26 ft. The total length of the tunnel between portals is 1,298.6 ft. The road-



Forbes Street Portal of the Tunnels



Cross Section of Armstrong Tunnels

way in each tube is 20 ft. wide between curbs and is paved with reinforced concrete. The clear height at the center of the tubes above the roadway is 21 ft. 7 in. A concrete wall 6 ft. thick separates the tubes, passageways between tubes being provided every 345 ft.

The roof of the structure is designed to withhold the overlying rock, should any movement or displacement of the rock take place in the future. Eight-inch steel arch ribs spaced 3 to 6 ft. are embedded in the concrete roof of the structure. Near the bottom of the arch ribs, holes were drilled through which ¾-in. tie rods were placed horizontally at 2-ft. centers. In general, the concrete tunnel lining is 2 ft. thick and is additionally reinforced with ⅝-in. square bars placed longitudinally at spacings varying from 9 to 24 in. and 1-in. square bars were placed transversely on 12-in. centers.

The grade of the roadway is 2.8 per cent, so there is no drainage problem. Artificial ventilation is unnecessary, so that the operating expenses are practically negligible.

Lighting.—The tunnel is illuminated by a line of lights placed in the roof of the structure at 40-ft. intervals. Glare from these lights has been eliminated by placing shield reflectors around them at the side of traffic approach. The portals are of reinforced concrete construction faced with Beaver Valley sandstone, with granite blocks used as trim around the arches and as coping.

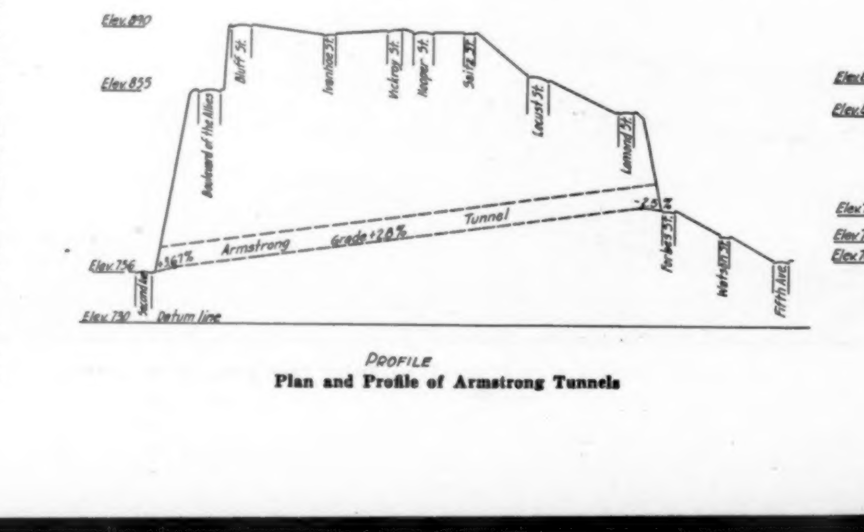
Excavation.—Construction of the tunnel involved the removal of approximately 112,000 cu. yd. of rock excavation. More than 35,500 cu. yd. of concrete masonry were used in the tunnel lining, foundations and portals. Other quantities were 7,450 sq. ft. of granite facing; 6,800 sq. yd. of roadway paving; 90,000 white glazed bricks for facing wall adjacent to sidewalk; 13,400 bbls. of cement for grouting and 330 tons of steel for reinforcing.

Financing.—Funds for this improvement were voted by the citizens of Allegheny County in April, 1924. At that time, a bond issue of $29,000,000 was voted for county improvements. Of this amount, $1,660,000 was set aside for the construction of this tunnel. The entire project was completed at a cost of approximately $1,540,000, which is well below the amount of funds provided by the bond issue. The above cost includes engineering expenses as well as all property damages incurred by the work.

Booth & Flinn, Ltd., were the contractors. Plans and specifications were prepared by the Bureau of Bridges, of the Department of Public Works and the project was completed under its supervision.

Proposed New Highway in Italy.—The Minister of Public Works, Giurati, on May 21 took part in a meeting held at Bergamo during which was discussed the proposed grand arterial autostrada running from Turin to Trieste, a distance of 542.39 kilometers. In his address to the meeting which was composed of delegates of the Fascist groups and federations interested, the mayors and civic leaders of the cities and provinces traversed, Hon. Giurati stated that ever since Ing. Puricelli presented a plan two years ago for the systemization of the Piedmont highways, the Government had had the hope of beginning such work but that for lack of finances it had been delayed. Therefore, the present adminstration felt pleased that private means had been found to carry to a completion such a worthy enterprise. At the end of the meeting a resolution was drawn up and unanimously adopted endorsing the proceedings. A commitee was created for stimulating interest in the building of such a roadway. Hon. Suardo, head of the Fascist Federation in Bergamo was made president of this committee. In view of the foregoing it is very likely that in due season, when funds are raised and proper surveys are made, this undertaking will be actually set in motion. The importance of such a highway can scarcely be computed. This section is the richest in Italy, agriculturally and economically.

Wayne County, Mich., Building Sidewalks Along County Roads.—The County Road Commission of Wayne County, Mich., is planning to expend $90,000 this year for constructing sidewalks at rural schools on county roads. This is the beginning of a program that will continue each year until all of the rural schools in the county are provided with sidewalk facilities for children attending those schools. This year about 15 schools located on the high speed and most important roads, will be taken care of.



Plan and Profile of Armstrong Tunnels

Handling Misfires in Open Work and in Tunnel Work

Safety Precautions Described in Du Pont Explosives Bulletin

By H. H. HAMILTON
Technical Representative, E. I. du Pont de Nemours & Co.

HANDLING a misfired hole is not a source of worry to the average blaster nor does he give it any thought. If he has a hole fail he generally does whatever comes to his mind first, and in almost every case the thing he does is very dangerous. Now this is all wrong. Handling a misfire is by far the most hazardous duty any blaster is called upon to perform and he should proceed with every precaution for his own safety and that of other men on the job.

In the first place, a large percentage of the misfires which occur could be prevented by making up the primers more carefully and, when electric firing is in use, by taking more time and pains with all the final connections. Most blasters get in a hurry just before firing a shot and this is the very time one should make haste slowly. When a misfire happens however, some steps must be taken. What can they be with the least risk?

Misfires in Open Work.—Let us consider failures of well-drill holes. Fortunately there are but few of these. When a well-drill hole does fail to fire it falls into one of two classes: first, holes which are so located that the total charge can be fired without danger to life or property; or second, holes which the original shot has robbed of part or all of their burden so that the firing of the charge would be a hazard.

In the first case, if the detonator is a good one and the wires are uninjured, the failure having been due to poor connections or insufficient current, the charge can usually be fired by a second application of the current. If this fails, the next expedient is to insert a fresh primer. The safest method of doing this depends upon the material used for tamping. The depth of tamping should always be known, for no good blaster would ever load a well-drill hole without measuring and recording the depth of tamping. If the stemming material is clay or loam, it is possible to take a pointed wooden pole or a piece of pipe with a sharpened wooden plug in the end, and work a hole down through the tamping to the top of the charge, and then push a new primer down through this hole until it rests on the charge. Water should be poured around the pole all the time the hole is being punched.

How to Remove Stemming.—If the stemming consists of sand or screenings it is not easy to put a hole through it, and the stemming must generally be removed from the hole. This can be done easily with a prospect auger or small post hole digger. Sand prospect augers are made in diameters of from 3 to 5 in. and are furnished with ¾ in. pipe fittings so that pipe can be screwed in to form a handle of any length required. Of course, in using such a tool care must be exercised as the charge is neared so as not to bore into the explosive. After the stemming is removed, a new primer is lowered into the hole.

Sand stemming can also be blown out of a well-drill hole by compressed air. The best method of doing this is to put down a 2 in. pipe in the center of the hole and blow out only the sand which rises in the pipe. This pipe serves as a sort of casing and should be left in the hole to prevent the remainder of the sand from falling in. The new primer is pushed down through the pipe until it is in contact with the original charge.

If the explosive is loaded solidly in the well-drill hole, a fresh primer can generally be relied upon to explode the whole charge, but if the load is broken, firing a fresh primer in the top charge would probably explode only this charge, leaving matters in worse condition than before. Therefore, in case of misfire of a deck-loaded well-drill hole, it will probably be necesary to remove both tamping and explosive down to the bottom charge.

If the misfire fails in the second class referred to, namely where the exploding holes have broken away the burden from the hole or holes that failed, it is likewise often necessary to remove part or all of the explosive. This is a dangerous operation at the best and should not be undertaken except by a competent and experienced man.

Tool for Removing Explosive.—A tool which has been used successfully for removing explosive from a well-drill hole can be made as follows: Take a copper or brass tube 4 or 5 in. in diameter and about 20 in. long, have the edges of one end of the tube sharpened and have two holes drilled on opposite sides about ½ in. up from this end. Then run a 14 gauge copper or brass wire through these holes across the diameter of the pipe and fasten it securely. Have the other end of the tube fitted with a coupling to take ¾ in. pipe so that a handle can be attached of any length required.

After the tamping has been taken out of the failed hole with the prospect auger, this tube can be pushed down into the explosive. The explosive will rise in the tube and when this is full the wire will serve both to cut the explosive off as the tube is twisted around and to hold the explosive in place until the tube can be lifted out of the hole and the dynamite removed. Then the tube can be put down again and the process repeated. A little water should be kept in the hole throughout the operation both to soften the charge and to prevent friction which might create sparks.

After enough of the charge has been removed to make firing of the hole safe, a new primer should be put in and the hole tamped. Water is the ideal material for tamping under these circumstances.

Sometimes the charges in the holes adjacent to the hole that fails break the rock to such an extent that the misfire is not discovered until the shovel digs into the bank and uncovers unexploded dynamite. In such a case the steam shovel and all other equipment, which might throw sparks or might be damaged by an explosion, and all workmen, should be withdrawn immediately to a safe distance. Then the blaster or some other man who has had experience in handling explosives should carefully remove the broken rock, keeping a sharp lookout for loose explosive, until the bore hole containing the charge that failed is exposed. Circumstances alone can determine whether it will be possible to insert a primer and fire the entire charge, or whether some of it must first be removed before the hole can be fired, or whether the entire charge must be removed from the hole. Whichever course is chosen, the careful procedure described in the preceding paragraphs should be followed.

In case of misfires in holes of smaller diameter than well-drill holes, it is generally necessary to remove the tamping in order to insert a new primer to fire the charge. This can be done by the use of a blowpipe and compressed air, or of water pressure, or of copper augers and spoons. The relative advantages and disadvantages of these methods as

discussed in the next section apply eqully to open work.

If a small diameter hole that misfires is a bench hole that has not been sprung, the best procedure is probably to drill another hole beside it, from one foot to two feet distant, depending upon the depth of the hole, and in such a position that a charge fired in the second hole will break the rock away from the first hole so that the unexploded dynamite can be recovered. A misfire of a sprung hole should never be treated in this way as there would be great danger of drilling into explosive in the chamber of in a crevice made by springing.

Misfires in Tunnels and Metal Mines.—The classes of work in which misfires occur in the greatest number are metal mining and tunneling. At one time it was considered a more or less standard safety practice in such operations that in case of misfire a second hole should be drilled parallel to the missed hole at a safe distance away, never closer than 1 ft., and that this should be loaded and fired, with the object of exploding the missed charge by concussion. If there is sufficient burden on the missed hole to make this feasible and if firing the second hole explodes the charge in the first, all is well: or if the shot does not explode the first charge but exposes the unexploded powder so that it can be recovered intact, this disposes of it safely. However, there is such grave danger that unexploded dynamite will be thrown out and scattered amid the broken rock and later struck by a pick or shovel that some important companies have rejected this practice altogether. If the practice is followed, careful search should always be made in the broken material for unexploded dynamite. A second hole should never be drilled alongside a misfired hole that has been chambered or in material where there are seams or crevices.

Dangers in Blowing Out Tamping.—Today, in underground operations other than coal mines, the common procedure in handling a misfire is to attach a metal blowpipe to the compressed air hose, run the pipe in the hole, blow out the tamping and insert a new primer. This use of compressed air for blowing out tamping involves several dangers. It is practically impossible to know when all the tamping has been blown out and if the primer is at the top of the charge and the blowpipe strikes it hard, the detonator may explode. This can happen whether the pipe be of steel, copper or brass. Moreover, when the charge is a granular explosive, the force of the air is more than likely to spread powder all along the sides of the hole, for the blowpipe is smaller than the hole and it is impossible to stop blowing the moment the charge is reached. In a bore hole coated with dynamite the friction of the pipe as it is run up and down in the hole or the blows which the force of the air causes the pipe to strike against the sides of the hole may easily start a premature explosion. Things that sound far-fetched, perhaps, actually happen with explosives. In one case, powder blown from a hole before the air could be turned off remained on an adjacent slab in sufficient quantity to explode when a workman struck the slab with a sledge and the man lost his eyesight. Instances are also known where some of the powder in a missed hole was blown by the compressed air into a crevice in the rock and was later drilled into and exploded.

When the missed hole is charged with gelatin dynamite the dangers of blowing out the tamping with compressed air are decreased but even then a metal blowpipe introduces a hazard. A substitute is a piece of stiff rubber tubing fitted with a coupling so that it can be attached to the air-line and also with a valve for controlling the flow of air. If it is desired to remove the explosive after the tamping has been blown out, this can be done by working the tube around in the hole until the force of the air has loosened up the charge and then gradually withdrawing the tube. The cartridges or chunks of gelatin will follow the tube up the hole and in this way the primer can often be recovered and the cause of the misfire ascertained.

If compressed air is to be used for blowing out tamping, the hole should be kept drenched with water. This is especially important if the charge is a granular explosive and if a metal blowpipe is used. The work should be done only under the supervision of a foreman or shift boss, and the greatest caution should be observed.

Safest Method of Removing Tamping.—In general, however, the safest method of removing tamping from a bore hole, and the one strongly recommended, is washing it out with water under pressure. The tamping usually needs to be loosened up first and for this a tool bing successfully used by two large companies is suggested. This is made from a coper rod three-eighths of an inch in diameter and about six feet long. One end is flattened for almost six inches to a width of one inch, and the tip is cut into the shape of a V and sharpened. This end is used for loosening up the tamping preparatory to washing it out with water. The other end is flattened for about fifteen inches to a width of one and one-half inches, this portion is heated and twisted somewhat like an auger and the tip is split like a coal auger and sharpened. This end is used for pulling out the tamping in case there is not sufficient water pressure to wash it out. The tamping is kept thoroughly wet while it is being loosened or pulled out. The companies referred to have standardized on a certain number of inches of tamping for every hole so that the blaster always knows just where the top of his charge is located. With the tool described a blaster can remove twenty inches of tamping in from ten to twenty minutes, depending upon conditions. Of course, ordinary copper augers and spoons may also be used, always, be it remembered, in conjunction with water, for loosening and removing tamping.

There was a time when only compressed air was available in many mines and tunnels but the modern drills are all equipped for wet drilling and water is now found in almost every working place, and, in many operations, under considerable pressure. Water pressure is a much easier, quicker and safer means of removing tamping from a missed hole and should be used in preference to compresed air whenever possible.

Grade Crossing Accidents

Since 1920 a total of 16,793 persons have been killed in grade crossing accidents, according to the American Road Builders' Association. The year 1927 was marked by a noteworthy decrease for the first time since 1900.

During 1927, a total of 2,371 persons were killed and 6,613 were injured in these accidents. Louisiana reported the highest death rate with 3.02 fatalities for each 10,000 registered automobiles. Mississippi was second with 2.02 deaths per 10,000 cars. The lowest fatality rate was found in Wyoming, where no persons were killed and only one injured at grade crossings during the year. Rhode Island had the low death rate of .08 persons per 10,000 automobiles.

At the beginning of the year the American Road Builders' Association asserts there were 206,533 unprotected grade crossings, an increase of 1,457 over the previous year. Texas had the largest number of unprotected crossings with a total of 11,771. Rhode Island had the smallest number of unprotected crossings, that state reporting but 58. Delaware was second with but 251. Wyoming, the only state which reported no fatalities, had 588 unprotected crossings.

A study of grade crossings accidents shows more persons to have been killed during the month of October than during any other month. The seasonable variation taken over a 5-year period shows 10.49 per cent of all fatalities to have occurred in that month, with the lowest death rate in February, when 6.23 per cent of the casualties occurred. Increased haulage of freight and additional highway traffic during the fall are believed responsible for this variation.

The County Highway Officials' Division of the American Road Builders' Association have organized a committee to study Grade Crossing Elimination and will report at the Convention that will be held under the auspices of the Association in Cleveland, Jan. 14, 1929.

Oil Mix Method of Treating Gravel Roads

Methods and Cost of Work in Wyoming

By C. H. BOWMAN

District Engineer, Wyoming State Highway Department, Casper, Wyo.

ASPHALTIC oil and coal tar have been used in treating gravel and macadam roads for many years with varying degrees of success. However, there has never been a time in the history of the use of bituminous binders and tars for road surfaces that scientific study, research, and control have developed as much interest and promise as at the present time. It is interesting to note, at the outset, the reason highway builders are taking so much interest in the relatively low type road surfaces of crushed rock, crushed gravel, and natural sand and gravel in connection with the bituminous treatment of these surfaces.

Suitable Low Costs Types Developed.—In this Rocky Mountain region, there has gradually been worked out low cost types of road surfaces which are constructed of local materials which are suitable for the traffic and are within finances available. Apparently a type of road construction suitable to our needs and in a measure possible to finance is being developed. In state work and in much of the county work there is a decided departure from the wasteful methods of building trails here and there with no definite plan in mind. On the other hand, all the funds are not being spent on high type construction, nor is all the money spent on short stretches of road, thereby leaving other portions scarcely passable.

Bituminous Binders.—The use of bituminous material for binding these fine crushed rock or crushed gravel surfaces gives promise at the present time of greatly increasing the beneficial use of this type of construction. During the latter part of 1927 one could scarcely pick up a publication that dealt even slightly with highway work without finding some article or allusion to the use of bituminous binders on gravel road surfaces. Bituminous surface treatment of macadam and gravel roads has been practiced for many years with varying degrees of success. Two general methods, the surface treatment method and the mix method, have been used. Where a solid, smooth roadbed has been surface treated, this practice has been successful and, for this method to be successful, it is necessary that the roadbed be compact and smooth. However, it is not the compact, smooth gravel surface that is worrying highway engineers and administrators. It is the gravel surface that is loose or full of holes that is causing the most concern.

Extensive Experiments and Investigations.—Wyoming does not claim to be the originator in the development of oiled gravel surfaces. During the years preceding 1925 many stretches of gravel roads were given the mix method oil treatment or the surface oil treatment. In 1925, extensive experiments with surface treatment and mix treatment of top soil or sand clay gravel surfaces were carried on by the South Carolina Highway Commission in co-operation with the U. S. Bureau of Public Roads. The results of this research and the conclusions reached are reported in the November, 1927, Public Roads. Following extensive experimental work in 1923, the Oregon State Highway Commission has constructed several hundred miles of bituminous treated roads. When the 1928 program is completed there will be 1,325 miles of this type of road surface in Oregon. Oregon's budget calls for an expenditure of $740,000 on oiled surfaces during 1928. The surface treatment method has been used almost exclusively in that state. In 1925 experimental work was carried on in California and in 1926 and 1927 extensive experimental and practical work, as well as co-operative investigation with the U. S. Bureau of Public Roads, was carried on. This investigation included the surface treatment and the mix methods. The mix method has grown in favor. Assistant State Highway Engineer Stanton of California, in the October, 1927, issue of American Highways, states: "Although about seventy-five per cent of the oiled roads in California are surface treated, there is no doubt that the oil mix method will be used to a greater extent in future work." The results of the experimental work in California and the conclusions derived from this research were published in the fall of 1927. This report was made by C. L. McKesson, Material and Research Engineer, California Division of Highways, and W. N. Friekstad, Highway Engineer, U. S. Bureau of Public Roads.

The report of McKesson and Friekstad is invaluable to those contemplating the construction of oiled gravel surfaces. The U. S. Bureau of Roads, with its control and influence over the federal aid highway system, with its eagerness and ability to spread the gospel of good and useful practices in highway building, together with the cordial co-operation between the states through the American Association of State Highway Officials, has made the processes employed, results secured, and conclusions drawn available for road builders everywhere.

It is interesting to note that Michigan is building a type of pavement on old gravel roads which is intermediate between the mix treatment and an asphaltic concrete pavement. This pavement is constructed by placing a two-inch asphaltic concrete top on the old gravel base after the base has been made uniform by a binder course of asphaltic concrete. This is another attempt to spread the available funds over more miles of highway in order to increase present beneficial use.

A Specific Project Discussed.—Although Wyoming, previous to 1927, had done some road oiling, using the bituminous surface treatment and the mix method, the first project attempted with a definite idea that the work would be successful was a 15.4 miles federal aid project in the summer of 1927. The mix method of treatment was used on this job.

It has already been stated that there are two general methods of construction which may be used. These are known as the surface treatment and the mix or process methods. In the surface treatment method with asphaltic oil, oil is applied under pressure to a smooth, compact roadbed, the oil is allowed some time to penetrate and the road is then covered with screenings to take up the excess oil. This process is usually applied a second time. The mix method is just what the name implies and involves a thorough mixing of the proper quantity of asphaltic oil with the material of the roadway to a depth that will secure a mat of the desired thickness. Asphaltic oil is mentioned because that kind of oil is available and is generally used in the western United States. Authorities differ on the relative value of asphaltic oil and coal tars. It is possible that the tars may be used as effectively as the bitumens. Due to the fact that loose and uneven gravel surfaces were generally encountered and also that the mix method is particularly adapted to the treatment of such

surfaces, this method was adopted for use on the federal aid project of 15.4 miles, which will be discussed. Previous to the beginning of this work, studies were made of reports of mix methods of bituminous treated roads which had been constructed in California. The District Engineer of the U. S. Bureau of Public Roads and the Chief Engineer of the Wyoming State Highway Department made personal inspections of the work then in progress at Barstow, California.

The organization of forces, equipment used, cost data, and results obtained as well as conclusions drawn from the construction and completion of the above mentioned project near Casper last year will probably be of interest. It had been previously decided that satisfactory results could be secured if the following conditions were met:

a. A pure asphaltic base oil of proper viscosity and asphaltic content should be used.

b. The oil should be thoroughly mixed with the road material.

c. It would be necessary to guard very carefully against the use of too much oil per unit of volume of gravel.

d. A certain brown color would indicate that the proper amount of oil had been used and that the oil and road material were properly mixed.

In initiating this project, W. A. Norris, Engineer of Materials, Wyoming State Highway Department was given supervision over the proper mixing and processing of materials. The difficult task of deciding the color which indicated the correct quantity of oil and proper processing was delegated to him. This decision was based on verbal reports previously given him.

It was fortunate at the time this work was started (late in July, 1927) seasonal maintenance, due to good weather, was at a minimum. The best of the maintenance and shop employees were selected to handle the work. The crews, equipment, and camp were carefully planned before starting the work.

This project, 15.4 miles long, is a part of the Casper-Salt Creek Oil Field Highway, a road which extends north from Casper forty-five miles to the oil field. This section carries a heavier traffic than other sections of U. S. Route 87-E, of which it is a part. With the exception of the project under discussion the road had been paved between Casper and the oil field under previous federal aid agreements. The project lies on the wind-swept plains at an average elevation of approximately one mile above sea level and the annual rainfall is about thirteen inches. Temperatures range from 35 deg. below zero to 95 deg. above zero.

Gravel Surface.—The placing of a crushed gravel surface 6 in. deep and 18 ft. wide was completed in October, 1926, nine months before oiling began. This material was placed in two courses of equal thickness and the first course was well compacted under the traffic before the second course was placed. This surface was "traffic bound" with an average daily traffic of 600 motor vehicles per day. As far as possible, the hauling units were utilized to compact the surfacing as it was being placed.

The gravel was a well-graded material of crushed granite gravel which had been carefully regulated at the plant. Specifications required all material to pass a screen with 1⅛ in. circular openings and more than 45 per cent of it was to pass a sieve with ¼ in. square openings. An average sieve analysis of the actual material used is interesting.

Gravel Screen Test

	Per Cent	Per Cent
Retained on 1⅛ in.	0.000	
Retained on 1 in.	5.445	
Retained on ¾ in.	19.443	
Retained on ½ in.	19.472	
Retained on ¼ in.	21.037	65.397
Retained on No. 10	15.700	
Retained on No. 40	14.393	
Passing No. 40	4.510	34.603
Total		100.000

It will be noted there is a small variation in the amounts that were retained on the ¾ in., on the ½ in., the ¼ in., the 10-mesh and the 40-mesh screens. This would indicate that the material should pack readily under traffic and such proved to be the case. Some of the gravel was lime coated and this undoubtedly contributed to the early binding.

The Oil.—The oil was produced under the following specifications:

Oil asphalt shall be a natural asphaltic base crude and shall have a specific viscosity (Engler) at 122 degrees Fahrenheit of not less than 25 nor more than 45.

Water and Sediment—Water and sediment combined shall not exceed more than 2.0 per cent.

Asphaltic Content—The oil shall contain not less than 60 per cent nor more than 70 per cent of asphaltic residue, having a penetration of 80 at 77 degrees Fahrenheit.

Test Methods—Test methods shall be as defined in U. S. Department of Agriculture Bulletin 1216 for all materials and tests involved.

The Midwest Refining Company, which has a refinery of 60,000 bbl. capacity at Casper, manufactured the oil. A pure asphaltic base crude oil produced from the Poison Creek Oil Field, 25 miles from Casper, was refined to meet the requirements mentioned in the specifications. In this work, the department made all possible use of the knowledge gained by the study of methods and equipment used in the extensive work already carried on in California under careful supervision and studious scientific observation.

As previously stated, competent men from the maintenance and shop organization were chosen for this work. All were interested in securing the best possible job at low cost. Some experience had been gained in handling the pressure distributor on previous surface treatment work. Regular maintenance equipment was used. The only new equipment bought was a double disc harrow and a spring tooth harrow.

A 2 or a 3 in. mat was expected from the application of one gallon of oil per square yard.

The sequence of operations was as follows:

a. Scarifying to depth of mat desired.
b. Discing and harrowing.
c. First application of oil (½ gal. per square yard).
d. Discing and harrowing.
e. Second application of oil (½ gal. per square yard).
f. Discing and harrowing.
g. Turning and mixing with graders.
h. Laying down for traffic.

Scarifying and Harrowing.—Scarifying was comparatively easy on this job because the gravel surface had been under traffic for only nine months. An Adams 8-B 10 ft. blade grader with scarifier attachment was used. A 10 ft. Holt tractor furnished the necessary power. This tractor pulled the scarifier with its full set of seven teeth. Generally three sets of teeth were used per day on the usual daily run of approximately 4,000 ft. A good set of teeth can be resharpened several times.

Scarifying was followed by the double disc harrow and spring tooth harrow. A 5 ton Holt tractor supplied the power. These two harrows in two trips over a given area pulverized and leveled the material satisfactorily.

Heating and Transportation. — Oil was delivered to a spur in tank cars. The average haul distance to the project was 9 miles. Advantage was taken of an elevated spur adjacent to an oil-field boiler house in order that the oil might be delivered by gravity into the tank trucks. Steam was introduced into the tank car steam coils and the oil was heated to approximately 120 deg. Fahrenheit. At this temperature the oil would flow readily under gravity into the tank trucks, and would pump readily from the tank trucks into the distributor and work through the distributor satisfactorily. Two and one-half ton trucks, on which were mounted 610 gal. tanks, were used to transport the oil from the tank car to the distributor on the work. Filling a truck tank by gravity from the tank car required about ten minutes. Pumping each tank of oil into the distributor consumed an equal amount of time.

Oiling.—Oiling was done with a pressure distributor operated with a chain

drive off the truck drive shaft. Efficient workmen, who had worked for the department for several years and who had had previous experience with the oiler, secured an extremely uniform distribution of the oil. The theoretical application of oil on this project was one gallon per square yard and the oil actually applied on the entire project averaged 0.9712 gal. per square yard. The distributor tank held 600 gal. One-half the road was covered at a time. Each tank covered 1,200 lin. ft. for each application of ½ gal. per square yard.

Harrowing.—As soon as the ½ gal. of oil per square yard had been applied on a stretch of surfacing the roadway was harrowed with the double disc harrow and the spring tooth harrow. A 5 ton tractor furnished the power for this operation. Two trips over a given area were made by this outfit.

Mixing.—After the oil had been applied and harrowed in, the mixing or processing began and continued until the oil was thoroughly mixed with the previously loosened and pulverized road material. Adams 8-B 10 ft. blade graders drawn by 10 ton Holt tractors were used for this work. The blades should roll the material instead of pushing it aside, because the rolling action will mix the oil with the material more quickly. Thorough mixing and processing until the oil is mixed uniformly with the proper amount of material is essential for a satisfactory job. It was necessary to turn the material over many times to secure a thorough mix. In our work not enough processing was done on the start and some of the mix appeared to have too much oil. Such a mixture is said to be "fat." A large part of the project was reprocessed, scarified, and remixed, reaching deeper for new material to get the leaner mix that seemed to be desirable. Some of this remixed material has ravelled slightly. This indicates a mix which was too lean. The surface which was processed most in the first treatment and not reworked is now in fine condition. An inspection of the road after six months' service indicates that expectations for this type of construction may be fulfilled, as the entire project is in excellent condition. Thorough and uniform mixing of the material on the road with the proper amount of oil is, without doubt, necessary in order to secure a first-class job. Too much study and care cannot be given to this processing. Laboratory control is essential to secure the best results and to furnish data from which to draw definite conclusions as to proper processes and results obtained.

Traffic Not Inconvenienced.—The average daily traffic over this highway project is approximately 600 motor vehicles per day, yet traffic was not inconvenienced to any extent during the time the work was carried on. The distributor covered 9 ft. or one-half the roadbed at one trip. While this half was being oiled, traffic used the other half of the roadway. As soon as the first part was oiled and while the distributor was being reloaded the harrowing of the first application was started. While the second half of the roadbed was being oiled traffic was allowed to use the oiled half of the roadway and, throughout the processing, the work was handled so that there was practically no splashing of oil on passing cars.

Crew and Equipment.—Information on costs may be of interest, so a brief summary of crew, equipment, and unit costs follows:

Crew

One superintendent foreman.
One mechanic.
Five truck drivers on trucks.
Four tractor operators, graders, and harrows.
Three blade and scarifier men.
One fireman.
One cook.
One handy man unloading oil at tank cars.

Equipment

One 60 HP. boiler.
Three 10 ton Holt tractors.
One five ton Holt tractor.
Four 2 ton trucks with 600 gal. tanks (hauling oil).
One 3 ton truck pulling maintenance blade.
Two light cars for mechanic and superintendent.
Four graders, 10 ft. to 12 ft. blades.
One double disc harrow.
One spring tooth harrow.
One water tank.
Camp wagons and camp equipment.

Rental and depreciation on all equipment was charged to the project. For example, a rental and depreciation of $18.00 per day on a 10 ton Holt tractor and $12.50 per day on a truck were charged into the job. Rental and depreciation rates on other equipment were charged at corresponding rates.

Cost Statement

Length of project, 15,487 miles—163,543 sq. yd.
Number of actual working days—20.
Average run, 4,088.56 ft.—8,177.12 sq. yd.

	Total	Per Sq. Yd.
Scarifying	$ 1,275.64	$0.0078
Oiling	1,063.03	0.0065
Harrowing	752.30	0.0046
Processing and mixing	1,275.64	0.0078
Finishing	703.23	0.0043
Oil delivered	10,630.30	0.0650
Overhead	752.29	0.0046
Total	$16,452.43	$0.1006

Oil at refinery	$0.045 per gallon
Freight refinery to spur	0.008 per gallon
Steaming and hauling, spur to project	0.013 per gallon

Conclusions.—Conclusions which have been drawn from a study of results obtained in other states and Wyoming experience to date are:

Asphaltic oil treatment of crushed gravel or crushed rock surfaces in this region is justified for the following reasons:

a. The cost is not prohibitive on large mileages of light traffic state and county roads.

b. The maintenance cost of the oiled surface probably will not exceed that of maintaining an untreated surface and is likely to be less. The original smooth surface can be renewed by scarifying and remixing at a reasonable cost.

c. The saving of road surfacing materials. (In some cases the annual saving in road material will pay for the cost of treatment.)

d. The treatment eliminates dust and decreases wear on tires and depreciation of machines because the road surface has increased smoothness. The fuel consumption of machines is also less.

e. This type of road is popular with the motor vehicle owner.

It should be remembered that:

a. The roadbed must be adequate to carry the expected loads. There must be sufficient metal present to take the treatment.

b. All materials should pass a 1 in. screen opening. This insures better results.

c. Great care must be taken to secure a thorough and uniform mixing of the oil and road metal.

d. An efficient organization which is interested in securing a first-class job at reasonable cost is necessary to secure satisfactory work.

e. Laboratory control and studious supervision of each separate project are essential.

f. An efficient maintenance organization must be available to give proper maintenance.

Indications are that this type of road surface has a very useful place in the highway field in this western region. Availability of materials, results thus far secured, and studious attention which is being given to the details of the work hold much promise for the future of this type of construction. It is not a cure-all. As is necessary with other kinds of road improvement, traffic conditions, materials, and organization should be carefully studied before the bituminous treatment of a crushed gravel or crushed rock road is undertaken.

Acknowledgment.—The foregoing is an abstract of a paper presented at the 1928 Highway Conference at the University of Colorado.

Increased Capacity of Drainage System.—In a discussion in the January 1928, proceedings of the American Society of Civil Engineers, L. L. Hidinger, president Morgan Engineering Co., Memphis, Tenn., stated that there has been a steady increase in the designed capacity of drainage channels. The first run-off curves provided for only about one-third the capacity that is now provided. Mr. Hidinger gave the following table to show the increase in capacity of dranage systems located in the Lower Mississippi River Valley within the last 18 years. The table is based on an area of 300 sq. miles:

Capacity of Drainage Systems.

Location	Year	Cu. ft. per second per square mile
Southeast Missouri	1910	7.4
Northeast Arkansas	1912	8.8
Southeast Arkansas	1913	13.5
Southeast Missouri	1924	15.4
Northeast Arkansas	1925	17.4
Southwest Arkansas	1925	20.0

What They Think of an Engineer for President

Editorial Comment on Nomination of Hoover

THE DAILY NEWS, Chicago:

For the first time in the history of the United States a great national party has nominated for chief magistrate of the republic a distinguished engineer and an internationally famous administrator. This is not wholly accidental, being in truth significant of the trend of modern thought and of the increasing public demand for constructive ability and scientific leadership in politics, legislation and diplomacy. . . . The nature of the problems now confronting the United States has created a demand among men of affairs for the objective mind, which approaches public questions in a spirit of impartiality and which insists upon knowledge and certainty as preliminaries to important action. . . . The republican national convention has nominated for president a strong and able man, a man essentially open-minded and constructive, a man of vision and wide experience. Whether his passion for efficiency has removed him in any degree from the plane on which best can be understood the trials and aspirations of the common man is for the American people to judge in the coming political campaign. Apparently he is the true and lawful heir of the Coolidge policies.

THE OREGONIAN, Portland, Ore.:

Hoover is well equipped to deal with domestic problems. He knows from his work as food administrator the basic facts about agriculture and his titanic struggle in the early months of 1919 to save the American farmer from ruin by saving Europe from famine is abundant proof of his sympathy with the farmer. That sympathy, joined with his knowledge of economic law, is assurance that he will find a plan to dispose of surplus crops without resort to economic quackery. The Government has entered upon a number of construction projects so vast as to require at its head a man with the ability of a chief engineer. Hoover is such a man.

THE VINDICATOR, Youngstown, O.:

In nominating Herbert Hoover for president the Republicans have chosen their best man. . . . Hoover is the country's great administrator. We have come to look to him for everything from directing Mississippi relief to reducing the number of radio stations, and from finding foreign markets for our products to standardizing the sizes of blankets and lumber and paving bricks. It is his business in life to eliminate waste and promote efficiency. If he is elected president we shall see the movement to make industry more productive carried to its logical conclusion. Washington will be filled with conferences of all kinds, in which men and women from every nook and corner of the country will meet to try and find better ways of doing things. A great administrator, a great organizer, Hoover would be a great engineering president. He would work to improve things, not in the interests of capital or of labor, but for the sake of doing the job better, of doing it the best way men know how.

PLAIN DEALER, Cleveland, O.:

It is a circumstance which invites new confidence in democratic government when a great party turns to a man like Herbert C. Hoover and makes him its nominee for President. Whether he is elected or defeated in November, Hoover brings character and promise to the Republican ticket. He is a new kind of candidate in a day surfeited with old forms and old habits in politics. Hoover typifies efficiency. He thinks in terms of getting things done. To him government is an engineering problem, and like a master chess player he maneuvers his forces to the desired end.

THE TRIBUNE, Chicago:

The nomination of Herbert Hoover as Republican candidate for the presidency was given with a majority so impressive and with an enthusiasm so genuine and unforced that there is left no doubt it expressed the preponderant will of his party or that Mr. Hoover can go into action with the confidence in the authority of his leadership and the loyalty of his support. . . . Perhaps Mr. Hoover's main appeal to the judgment of the country rests upon his accomplishment in the gigantic task of war relief in Europe, a task of unprecedented scope and complicated difficulties, both administrative and diplomatic. In Belgium and western Europe, and later in center and eastern Europe, Mr. Hoover demonstrated executive genius of the first order. Returning to the United States, he has served with great ability in the administration of three Presidents, in various capacities, but most notably as secretary of commerce in the cabinets of Harding and Coolidge. His conduct of the department of commerce has been marked by initiative and creative energy. . . . For demonstrated executive ability, no candidate has ever sought the office of chief executive with greater justification.

THE STAR, Kansas City, Mo.:

In Herbert Hoover the Republican party has nominated a man with a remarkable training for the presidency. He has the background of working on the farm as a boy. He has had large business experience. He is an expert on foreign affairs. He has a passion for the big problems of an economic age. He has had ten years in Washington in contact with public questions, with congress, and with public men. He has administered a great government department. . . . There is the human side to Hoover that the country will learn as it becomes better acquainted with him.

POST-GAZETTE, Pittsburgh, Pa.:

Herbert Hoover has been nominated for the presidency of the United States at the Kansas City convention. . . . Mr. Hoover's marked ability has been demonstrated again and again in his long years of faithful service. His personal integrity and character are beyond question. In the light of his record as Secretary of Commerce in the administrations of President Harding and President Coolidge all citizens can rest confidently in the assurance that he will make a capable President.

DAILY JOURNAL, Elizabeth, N. J.:

The logical as well as the expected has happened in the nomination of Herbert Clark Hoover for President by the Republican party. Seldom, since the time of Lincoln, has the party made so good a choice. It has seized and firmly held one of the greater opportunities of its existence. It would be difficult in this time to find a man so consummately adapted to the occasion, and to the needs of the country. Herbert Hoover has long represented the most constructive of statesmanship in aggressive action and performance. The country, and the world at large, has turned to him to undertake great tasks. He has easily taken them upon his broad shoulders and performed them. He has a mind that plans work that is enduring. . . . The record of Herbert Hoover shows him not to be just a prominent American among prominent Americans; but a builder of American and world welfare, who stands as high as the highest. He has exhibited a positive genius for construction; and his character stands for moral construction, as his achievement has registered so greatly in solving the more material problems of the nation. He has a genius for serving human welfare; and that is the type of man who appeals to Americans in these reconstruction days. He is a man of boundless resources, as his record shows.

Surface Treatment of Macadam in France and Germany

Methods of Using Emulsified Asphalt

By C. L. McKESSON
Materials and Research Engineer, California Division of Highways

DURING recent years the road engineers of France and Germany have begun the extensive use of emulsified asphalts, both in surface treatments and in penetration macadam or "grouted" macadam, as such surface is there known.

Splendid Macadam Contributes to Success.—The very remarkable success which appears to have been secured with the use of asphaltic emulsion is probably due in no small measure to the fact that the macadam surfaces usually have adequate foundation. This foundation usually consists of a Telford base, or of very heavy layers of stone compacted often by centuries of traffic. The macadam surfaces also have been well built. Another factor of even greater importance is the extremely careful and conscientious manner in which the various operations are conducted, particularly the cleaning of the surface upon which bitumen is to be spread.

Several Types of Emulsions.—There are several kinds of emulsified asphalt in use. Various emulsifying agents are used, including clay, soap, and various alkalis, and it is believed that the successful results obtained may in some measure be influenced by the purity of the emulsion. An emulsion to be suitable for this work must remain in liquid condition without separation for an indefinite period prior to application. Three to six months is probably sufficient for usual requirements. It must flow freely, penetrate readily, break down soon after application and, upon breaking down, must leave a layer of pure bitumen on the rock particles. If the emulsion is to be used in wet or damp weather it should be one which will break down without drying out. A clay emulsion, for example, must dry out in order to break down and to become effective as a binder. The most successful emulsions break down when exposed to the air without drying out, merely by the separation of the bitumen and the water. In the better grades of emulsion the asphalt is very finely divided, the mixture being almost colloidal in character. Any commercial grade of asphalt or road oil may be emulsified, but in the European work it has been customary to use an asphalt having a penetration of about 150 at 77° F.; in other words, what is known in California as Grade "E" asphalt.

Surface Treatment of Macadam.—Surface treatment observed by the writer in both France and Germany was applied to waterbound macadam or as a cover for stone-block pavements. In either case, the existing surface was first thoroughly cleaned, and if a macadam before the application of emulsified asphalt the embedded stone particles stood out in well defined mosaic. The very successful results must, in a large measure, be attributed to the thoroughness of preparation of the existing roadway.

In France the removal of the dirt and mineral binder from the surface of the road was usually accomplished by washing and brooming. Just how thoroughly this work was done will be evident from the accompanying illustrations.

A Surface Treatment Job.—Fig. 1 is a view of a typical recently completed waterbound macadam surface on Chem. Gr. Com. No. 21, between Plauzat and Champeix in Central France, which is about to be surface treated with emulsified asphalt. It will be noted that this surface is well bound and that there is a thin layer of fine material in the places covering the macadam stone.

Fig. 3 shows the water tank with broom and washing nozzles used on this job. This type of outfit has been used very extensively and is quite efficient in

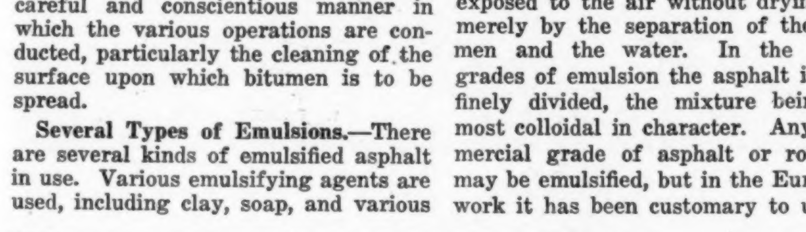
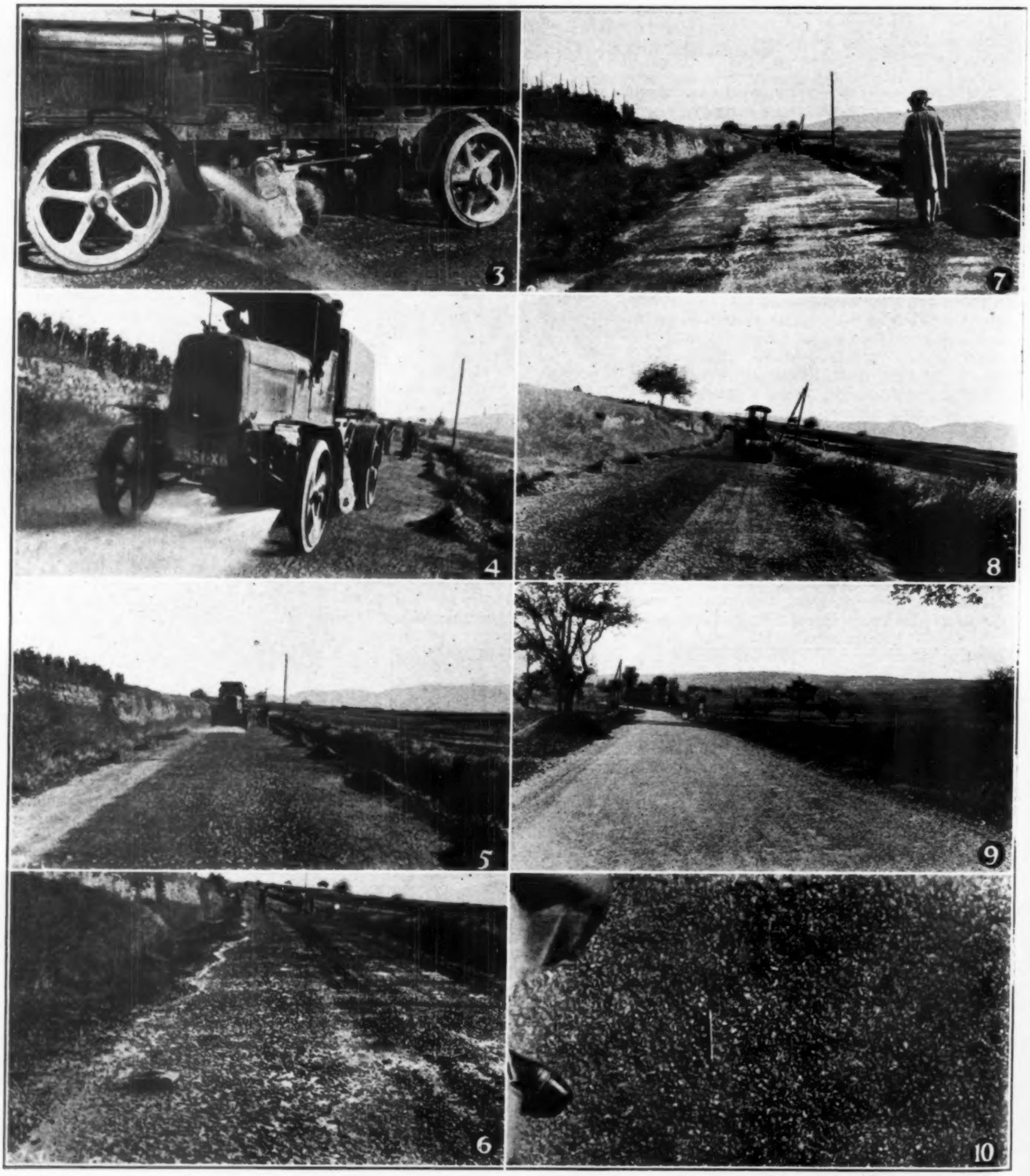


Fig. 1.—View of Road Shown in Fig. 2 After Surface Treatment with Emulsified Asphalt

Fig. 2.—Recently Completed Waterbound Macadam Between Plauzat and Champeix in Central France

removing fine material from the surface of the metalled roads. It will be noted that one pair of nozzles throws water backwards toward the broom. Fig. 4 is a front view showing the machine in operation. The broom revolves continuously and dislodges the material which has been softened by the action of the water. As the cleaner moves up and down the road the dirt and break is gradually driven over the shoulder of the road and into the ditches. How well the machine does its work is illustrated in Fig. 5, which is a view of the same surface shown in Fig. 1 after the cleaning rig has passed over it several times.

Fig. 6 is a view of the surface after it has been worked and cleaned ready for the application of the emulsified asphalt. At this stage the rock particles are not only standing up in relief but are free from a film of mud and the asphalt applied in the emulsified form can be expected to take hold of them.



Figs. 3-10—Surface Treatment Operations on a Waterbound Macadam Road in Central France. Fig. 3—Spraying and Brooming Outfit. Fig. 4—Front View of Machine in Operation. Fig. 5—View of Surface After Cleaning Rig Has Passed Over It Several Times. Fig. 6—Surface Ready for Applications of Emulsified Asphalt. Fig. 7—Spreading Screenings Over Fresh Emulsion. Fig. 8—Rolling the Surface. Fig. 9—Section of Finished Road. Fig. 10—Close-up Showing Texture of Pavement

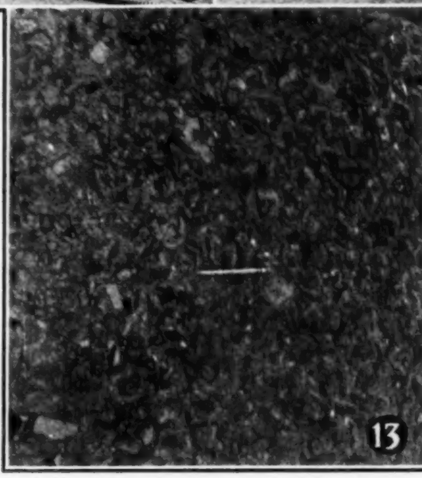


Fig. 11—Cleaning Macadam with Compressed Air
Fig. 12—Completed Surface in Foreground; Blowing Operations in Progress in the Distance
Fig. 13—Surface After Fines Have Been Entirely Removed by Blowing

The emulsified asphalt was applied on this particular piece of work with a tank sprayer using a centrifugal type of spreader. The total amount of emulsion was .55 gal. per square yard applied in a single application. The usual practice ranges from .45 to .55 gal. per square yard. Immediately after the application, stone chips from ⅜ to ¾ in. in size were hand-spread over the fresh emulsified asphalt covering at the rate of 25 lb. per square yard.

In Fig. 7 the men are shown spreading screenings over the fresh emulsion which has been placed on the road to a point near the fourth pile of screenings shown in the foreground.

Brooms are used to distribute the screenings over the fresh emulsion. It was interesting to note that the emulsion behaves very differently from hot asphalt in that it remains wet and sloppy and thoroughly coats all of the screenings distributed over the surface. Had hot asphalt been used under the same conditions it would have become more or less chilled and the screenings which did not come into actual contact with the hot oil would have remained uncoated and a portion would later have been thrown to the shoulders by passing traffic.

After the screenings are uniformly distributed, the surface is rolled with a 10-ton roller (see Fig. 8). The roller beds the screenings and produces a uniform texture.

Fig. 9 shows a section of the same road which had been finished for about two weeks at the time of the inspection. The uniformity of the texture of the surface is particularly worthy of note. There is a complete absence on this and on similar jobs of "fat" spots due to pockets of bitumen. The screenings have apparently all remained on the road.

Fig. 10 is a close-up showing the texture of the pavement shown in Fig. 9. It will be noted that, while these screenings have all been held and have produced a very satisfactory non-skid surface, the coating is thin and not glassy. as would be the case if an excessive amount of bitumen had been used. This non-skid texture remains for a long period after the road is subjected to usage, as was noted in many instances.

Fig. 2 shows another section of the same road and is very interesting in that it shows the steel drums in which emulsified asphalt is delivered to the road. The road sign is also unusual. It consists of a rectangular block of concrete about 18 in. square with metal face plates showing the designation of the intersecting roads. The sign is supported by a 12-in. concrete column and, needless to say, is safe from injury by vandals such as deface our highway signs. Michelin, the tire manufacturer, has donated these signs to this department and they are placed at every intersection.

Air Cleaning of Macadam.—While the washing, sweeping operation, as above described, has been the one most generally used in Germany and France, a new and very interesting method was being developed at the time of the inspection by Herr Kirschhof, a road engineer in charge of the roads in the Ahr Valley in Germany. This method has since proven its usefulness and is now being used in both Germany and France. It consists of removing the binder and surplus fines with compressed air produced with an Ingersoll-Rand portable compressor, operating at a pressure of three atmospheres.

In Fig. 11 the operator is shown with a valve controlled pipe having a nozzle tip which is used to direct the air against the road surface. The dirt and fine material is readily dislodged by this air jet. Fig. 12 is a view of the surface after the fines have been entirely removed by blowing.

Fig. 12 shows the completed surface in the foreground with the cleaning operation in progress in the distance. It was at first believed that some difficulty might be experienced with the blowing method on wet roads. Subsequent experiments have been conducted along this line and it was reported that the blowing works equally well whether the road is dry or damp. Where water is hard to obtain it is believed that the blowing process will be found more economical.

Other Examples of Surface Treatment.—Surface treatment practice as above described is more or less typical, but as was to be expected, some variations were found in different localities. An interesting piece of successful work was found on the highway in Germany in the Ahrtal between Sinzig and Bodenbach. This old road consisted of a macadam on a Telford foundation which was resurfaced as waterbound macadam, using 2½ in. of basaltic rock. After completion this waterbound macadam resurface was swept first with hard steel brooms then with ordinary brooms until a mosaic was produced; .44 gal. per square yard of emulsified asphalt was then applied in one application and covered with about 16 lb. per square yard of clean stone chippings. Four weeks later a seal coat was applied consisting of .22 gal. of emulsified asphalt which was again covered with fine chips.

Surface Treatment on Broken Stone Surfacing.—The surface treatments above described were applied to old waterbound macadam or to waterbound macadam resurfacing over old macadam. Such foundations are of undoubted strength and stability. That such treatments are equally applicable to newer roads, provided there is adequate thickness of metal, appears to be

demonstrated by the Puy-de-Dome road near Clermont-Ferrand in South Central France.

This interesting road was built by a private toll road company in 1926 to replace a cog railway used to carry passengers to the summit of a volcanic peak some 4,000 ft. in height which bears the name given to the road. The road completely encircles the mountain in the ascent and has a uniform gradient of 12 per cent. The president of the company which owns the road, M. Claret, stated that they had some misgivings regarding their ability to secure a non-skid bituminous road on this steep grade, but they have been successful in this regard. After grading, the road was surfaced with basalt crushed to pass a 2½-in. circular opening screen. The material was graded as it came from the crusher down to and including the dust. The material was placed in two courses, each from 4 to 6 in. in thickness. Each layer was rolled thoroughly with a 10-ton roller, but only a small amount of water was available. The surfacing was completed in July, 1926, and allowed to go through a winter season before bituminous treatment. In April and May, 1927, the road was thoroughly swept until the coarse rock was brought out in a mosaic. .45 to .55 gal. per square yard of emulsified asphalt was then applied and covered with 20 lb. of ⅜ to ¾-in. screenings. The screenings were lightly rolled after application.

Acknowledgment.—The matter above is taken from a paper presented by Mr. McKesson at a meeting of the Western Association of State Highway Officials.

New Highway Director Appointed for Ohio

Announcement is made of the appointment, effective June 15, by Governor Donahey of Harry J. Kirk as Director of the Ohio Department of Highways. There is no State Highway Commission in Ohio. The director is appointed by the governor and is the responsible head of all state highway activities.

The new director will have charge of a program involving the expenditure of $30,000,000 in 1928, comprising the maintenance of the 11,000 mile state highway system and the construction of 600 miles of new pavement.

Harry J. Kirk has been employed in the Ohio Department of Highways since December, 1913. He has grown up with the department, starting in a minor engineering position and being successively promoted to division engineer, maintenance engineer and chief engineer, which position he has held for the past three years.

He was born at Defiance, O., where he received his A. B. degree from De-

Harry J. Kirk

fiance College. In 1913 he graduated in civil engineering at Notre Dame University.

Mr. Kirk has been active for several years on committee work of the Mississippi Valley Conference of State Highway Departments, the American Association of State Highway Officials and the Highway Research Board of the National Research Council, and is well known throughout the United States among those in touch with highway activities.

A Time-Saving Reference Work for Road and Street Men

Whether his need is specifications covering the most modern methods in road construction, cost data with respect to the latest practice of construction or maintenance, or information regarding equipment of modern type, materials or supplies, the road contractor, engineer or public official turns to the Road and Street Catalog and Data Book with his problems and finds the answer.

This has become the established habit of progressive road men and it has proved a saver of valuable time as well as a highly appreciated convenience and service.

This reference work is the solution to hundreds of problems constantly presented to road and street men which accounts for the fact that it has become the standard source of reference upon which they daily depend.

As one sometimes wonders how industry could be maintained if the telephone and automobile were eliminated, so we are reminded of the difficulties that would confront the active, progressive man in the highway industry if he should be deprived of the inestimable benefits afforded by the Road and Street Catalog and Data Book.

Hundreds of letters of appreciation have been received from road men who have found this book to be an indispensable time-saving guide and tool. The following is from F. M. End, County Superintendent of Highways, Kankakee, Ill.: "We have found it to be of vital importance in our work. The Data Section is very helpful and contains the necessary information sought for each day by road men."

Philadelphia Bars Foreign Cement.—The City Council of Philadelphia, Pa., on June 28 adopted a resolution barring foreign materials from use on all city work. The action came about through efforts made to commit the city to the use of Belgian cement. Labor organizations opposed the movement, contending the loss to cement workers by the use of foreign material would run into millions.

200,000 Men on Chinese Road Job.—According to the U. S. Trade Commissioner at Shanghai. 200,000 men are at work on a road in Kweichow Province, China. They were placed there by the Military Governor of the Province in an effort to complete the road building project from Anshunfu to Chiuhui, a distance of 350 miles. Already 200 miles have been completed, and by the end of the year it is hoped to have the road through to Chiuhui.

Colors Indicate Direction on New Jersey Roads.—Motorists who travel into New Jersey henceforth will have one touring difficulty disposed of—that of being sure in which direction one is traveling. Telephone and telegraph poles are banded in colors. These colors indicate direction as follows: Blue, north and south roads; red, east and west roads; yellow, northwest and southeast roads, and brown, northeast and southwest.

Michigan Has 7012 New Highways Under Construction.—Outstanding state highway contracts calling for an expenditure of $18,437,000 are now underway in Michigan. The work totals 701 miles and includes 464 miles of concrete pavement.

Progress on the Central Highway of Cuba.—On May 21, 1928, there were 7,855 laborers employed on the construction of Cuba's Central Highway, divided by provinces as follows: Pinar del Rio 1,680, Habana 681, Matanzas 847, Santa Clara 557, Camaguey 1,727, and Oriente 2,363.

Relation of Foundation to Type of Highway Bridge

Experiences in Wyoming, Colorado and New Mexico

By P. S. BAILEY
Bridge Engineer, Colorado State Highway Department

IN preparing this paper on "The Relation of Foundation to the Type of Bridge," an attempt has been made to confine the remarks more particularly to conditions as they exist in Wyoming, Colorado, and New Mexico. Crossings of navigable streams will not be considered. This does not limit the discussion as much as one might assume at first thought, for, where can more varied conditions of foundations be found than those in these three states? Any material from solid, igneous rock in the mountain ravines to unstable quicksand in the broad valley streams below may be encountered.

It has been said that every bridge must be designed to serve two purposes; traffic over it, and water or traffic under it. This might well be extended to include a third purpose; namely, to serve the natural foundation material supporting it.

Classification of Bridge Structures.—For the purpose of this discussion, bridges will be considered under three heads; namely, foundation, substructure, and superstructure.

Foundations.—A classification, according to the kinds of materials of which they are composed is desirable. Named in the order of their supporting power, these materials may be classified as follows:

a. Alluvial soil or quicksand, good for not over ½ ton per square foot.

b. Clay and loam, if dry and firm, may support 3 tons per square foot.

c. Sand and gravel will support from 4 to 6 tons per square foot.

d. Shale, hard pan, cemented gravel and boulders, from 6 to 10 tons per square foot.

e. Sandstone and rock ledges, from 10 to 15 tons per square foot.

f. Solid and very hard rock, from 20 to 40 tons per square foot.

Substructures.—A general classification of substructures according to type is as follows:

a. Mass footing.

b. Spread footing.

c. Pile footing.

d. Open method pier.

e. Pneumatic method pier.

Superstructures.—These may be divided into the following types:

a. Simple spans.

b. Continuous and cantilever spans.

c. Spans integral with the substructure.

d. Suspension bridges.

The first problem in the designing of any bridge is to select the type of structure suitable for the location. The next problem is to choose a substructure adequate to transfer the loads to a foundation material which must have sufficient supporting power to sustain these loads without causing undue settlement.

Simple Spans.—The simple span is the first which will be considered. Probably 75 per cent of all the bridges with which the writer is concerned are simple spans. Simple spans may be constructed of concrete, steel, or wood or of a combination of any of these. If built of wood, they will usually be in the form of timber trestles. This means piling or framed bents will be used for the substructure. As stated by Mr. Gow in a paper before the Engineering Society of Western Pennsylvania: "The main purpose of a pile is to transfer a definite load down through layers of unsuitable soil, either to impose that load on a lower stratum of good material, or to compact, a uniform material so that it is capable of sustaining the pile by friction."

Wooden piles are estimated as capable of carrying from 10 tons per pile for soft native wood, to 20 tons for structural grade timber, such as long-leaf yellow pine, douglas fir, or oak. Cololrado uses a maximum of 15 tons per pile.

The use of piles, of course, presupposes foundation material such as loam, quicksand, sand, or gravel, which will be suitable for driving. In order that the piles may function to full capacity and that their working zones may not overlap, the piles should be spaced not closer than 2 ft. 6 in. center to center and they should preferably be kept at 3 ft. centers.

Two methods are used to estimate the required length of piles in locations where piling is not driven to a solid stratum. A test pile may be driven and a record kept of its resistance to driving with a certain weight hammer. The Engineering News or some similar formula is then applied to determine its supporting power. The other method involves the use of empirical, frictional values, which are assigned to the different materials encountered in a test hole previously made at this location. From these data, a definite length of pile may be calculated. One objection to the test pile method is that a single pile usually will act in the same manner as a group of piles spaced close together. The chief criticism of the frictional resistance method is that the frictional values are not reliable because the materials encountered will have different degrees of saturation.

Where solid foundation material is found near the ground surface and it is desired to use a timber trestle, a series of framed bents resting on short concrete pedestals is often used. The span of timber trestles is usually limited to the economic and physical length of the wooden stringers. The Colorado highway standard timber trestles are 19 ft., 23 ft. and 27 ft. in length. The 19 ft. span usually proves to be the cheapest. A bridge with a 20 ft. roadway is usually carried on four piles per bent.

The Colorado State Highway Department has had considerable success with this type of construction with a wire-mesh reinforced concrete floor. Several of these structures have been in successful operation four and five years. The success of this type depends on driving the piling far enough to insure that settlement and scour will be negligible.

Where heavy drift is a controlling factor, wooden trusses of longer spans may be used. These structures are usually supported by some gravity type of substructure, such as timber cribs on boulder foundations.

As regards simple spans of concrete, the Colorado State Highway Department uses a flexible type of structure. If properly constructed this is a satisfactory type from the standpoint of appearance and strength. The increase in weight of this type over similar steel and timber structures necessitates heavier substructures. These in turn call for more stable foundation material but, for these reasons, this type has a stability and permanency much to be desired. Since this bridge is required to carry such a heavy load, it is apparent that the attending live load has less relative effect on the stresses, and for a proportionately small increase of material, this type of structure can easily be made to carry probable future increases in live load.

Concrete spans are usually supported by concrete substructures. Any of the above mentioned types of substructure may be used with concrete superstructures. If soft foundation material obtains and drift does not prohibit short

spans, concrete piling may prove to be the most economical substructure for multiple spans up to 35 ft. Beyond this pan, the dead load becomes so great that concrete piling is not the most economical substructure to use.

The Colorado standard for concrete pile trestles calls for 20 ft. slab spans (possibly a little short for economy) carried by four reinforced concrete piles. These piles are 14 in. or 16 in. square, depending on the length, and are tapered for the last 5 ft. The estimated maximum capacity for each pile is 30 tons. To date this state has used over 20,000 lin. ft. of concrete piling in lengths varying from 18 ft. to 42 ft. Colorado experience indicates that for success with this type of substructure, adequately cured piles are required and a power driven hammer of sufficient force to overcome the dead load inertia of the pile must be used.

For the longer concrete spans, a different substructure is required. Concrete spread footings, mass concrete, masonry, or caissons are required, depending on the nature of the foundation material. The Colorado State Highway Department has used simple spans up to 50 ft. in the form of reinforced deck girder types and up to 60 ft. in reinforced through girder types. These spans are very heavy for their length and require stable substructures. If a stable foundation material is within 15 ft. of the stream bed, the gravity or spread footing is probably the best type to use. Where unstable foundation material is found below this depth, it will usually prove more economical to extend the solid footing to a depth below scour action and then carry the footing on some kind of piling to a safe bearing stratum.

The simple span type of steel bridge is a structure which, with proper maintenance, will last indefinitely. In case it becomes obsolete in one location, this type of structure has the advantage that it can be taken down and used in another location where the traffic conditions are less severe. Since this type is so flexible as to span length (it is used for spans up to 300 ft. in length), the question as to the economic span length for any particular foundation often arises. With the possible exception of some economic principles given by Dr. J. A. L. Waddell in his book, "De Pontibus," there is not much information available on this subject. In this book Dr. Waddell makes the general statement that "the greatest economy for a series of simple steel spans exists when the cost of the pier equals one-half that of the trusses and laterals for the two spans which it helps to support." In a later paper* entitled "Economic Span Lengths for Simple Truss Bridges on Various Types of Foundation," Dr. Waddell qualifies this statement by restricting it to the case where the piers rest on hard material at depths not in excess of 50 ft. He further shows that the economic span length increases with the depth of foundation, though not necessarily in the same proportion. The above principles might be used satisfactorily for approximately the economic span length. However, the final solution ought to be based on detailed calculations for the particular bridge in question.

*Journal, Western Society of Engineers, October, 1927.

To the writer, the selection of the type of pier to be used is the critical part of this problem. When coarse sand and gravel are present, or even medium stiff clay, wooden piles below the scour lines probably make the most economical type of pier. If the subsoil is composed of quicksand, soft clay, or any loose material in an aqueous or semifluid state, piling will prove ineffective, and some caisson or sheet pile method will have to be used. Caissons may be of timber, concrete, or steel, and may be circular or rectangular in plan.

Sheet piling, if properly braced, can be used economically for coffer dams to depths of 50 ft. For greater depths some form of concrete or steel caisson is necessary. If the final resting place for the caisson is on rock not over 110 ft. in depth, the pneumatic process is preferred, especially if there is a likelihood that obstructions, such as logs or boulders, may be encountered in its downward path. This method also has the distinct advantage that when down to its final resting place the foundation material can be properly inspected, and a seal coat of concrete can be placed on the bottom under favorable conditions. The open dredging caisson method will prove to be somewhat more economical if it can be used. Colorado has had very good success with one bridge project on which the piers were of the open caisson type. In this case, two hollow reinforced concrete cylinder piers 6 ft. 6 in. in diameter were sunk in 10 ft. sections for a depth of 35 ft. through sand and gravel to a bed of shale. These cylinders were equipped with a steel cutting shoe on the bottom. After sinking, the cylinders were filled with a 1:2:4 mixture of concrete.

Sometimes it may prove more economical to use the open type caisson method to a certain depth and then box off the bottom and complete the excavation by the pneumatic process. In all caisson construction, the caissons should be sunk to a hard stratum or at least well below the scouring depth. In the latter case piling is driven below the excavation into the underlying material.

Another form of substructure which may be used under certain conditions is made of steel piles. This substructure is generally used on short single spans where the height from the stream bed to bridge floor is not greater than 10 ft. Care must be taken to use piling of sufficient cross section to prevent buckling when the piles are being driven. Probably they should weigh not less than 30 lb. per foot.

In designing the end abutments for all spans, it will usually prove more economical to extend the superstructure an extra span, and use an open type of abutment which allows the earth to spill through at its natural slope. Very often, too, this additional span will bring the abutment to a position on the bank where the depth to suitable foundation material is considerably less than in the first case, thereby saving in the actual depth of the abutment. Care must be taken in using the method of open abutments, since a swift stream which carries considerable water at floor stage might easily wash out around the bridge. In nearly all places where this type of abutment is used, a grouted riprap is placed on the slope. This extends well above high water and around the sides of the approach fill. To prevent future settlement of this fill, it is important to secure thorough tamping during construction.

Continuous and Cantilever Spans.—In selecting a continuous or cantilever type of superstructure, the foundation material is of paramount importance. It must be unyielding, which necessarily precludes the use of pile substructures and implies rock or shale foundations. Concrete and steel are used for this type of superstructure. Concrete is used for the shorter spans and steel is used for the longer ones. Five bridges with continuous concrete spans have been built in Colorado, to date, and they are giving very good service. A continuous structure having a center span of 60 ft. and two outer spans of 45 ft. each has been found quite adaptable for highway overpasses in railroad grade separations. Steel spans of this type are usually confined to high level crossings over navigable streams, or where the substructure necessitates a very expensive layout, cases which, as a rule, do not exist in this locality. This type usually applies to spans over 300 ft. in length.

Spans Integral With Substructures.—For the case of spans integral with the substructure, there are steel, concrete, and masonry arches. Sometimes a simple span truss or girder is built integral with the piers. The arch type is not suited to piling foundations, due to the poor resistance developed by the piling to horizontal thrust. This condition is sometimes overcome by giving the piling a batter in the direction of the thrust.

An interesting case developed recently. An attempt was made to raise the roadway on a flat earth filled spandrel arch of 125 ft. span by means of a reinforced concrete open spandrel arch, superimposed on the original arch ring. The object was to perfect a grade separation over some adjacent railroad tracks. The original arch was built in 1908 and was serving its purpose very well, even though the heavy mass abut-

ments were supported by wooden piling. Plans were progressing very satisfactorily until it was discovered that due to the change in type of spandrel, the capacity of the piling would be overtaxed, and it was finally decided to tear out the arch completely and substitute a deck steel span on the old abutments.

Suspension Bridges.—Suspension bridges are in a class by themselves, and are generally used where long spans are required, and are best adapted to solid foundations both for the anchorage and towers. To the speaker's knowledge, no bridges of this type are to be found in this region.

Conclusions.—In conclusion, the importance of obtaining adequate field information before starting a design cannot be overemphasized. This is especially true as regards foundation data; for, on the accuracy of this and the application of it to the design, depends the success of the bridge from both an economical and a safety standpoint.

Acknowledgment.—The foregoing is a paper presented at the 1928 Highway Conference at the University of Colorado.

Shell-Asphalt Pavement

Early in 1925 the Engineering Experiment Station of Louisiana State University, under the acting director, Professor John H. Bateman, planned a number of experiments with material suitable for medium traffic. A section of the Baton Rouge-Hammond highway was selected for the experiment. Seventeen 2,500-ft. sections were laid out and each section given a different or modified type of surfacing.

Wearing courses of 1 in. sheet asphalt, rock asphalt, asphaltic concrete, Warrenite-bitulithic, and shell-asphalt were laid with and without asphaltic concrete bases. Varieties of coarse aggregate in base and curbs on the different sections included washed gravel, sand-clay, and crushed slag. On all sections without the base course the thickness of the wearing course ran from 1½ to 2 in.; the shell-asphalt was uniformly 1½ in. thick. We are indebted to the May Highway Magazine for the following details regarding the shell-asphalt pavement.

Unusual interest was taken in the shell-asphalt sections, as reef shell is available in many localities and has given good service under certain conditions of use. If successful under traffic in combination with asphalt, it would offer a widely available, low cost method of reconstructing or resurfacing worn gravel.

Mixing Method for Shell Asphalt.—The mixture tested out contained two sizes of crushed reef shells. It was at first believed that difficulty would be encountered in mixing the shell with the asphalt, but this fear was not justified. The shell was heated to about 325° F. before attemping the mixing process. This heating produced a fluffy condition, which, while rendering the mixing process easy, naturally made it necessary to reduce the mixing batch to about one-half that used ordinarily. Similarily, each truck load was reduced on account of the large volume. The uncompacted thickness of the shell-asphalt layer was made greater than that of other surfacing material, as it was found that the thickness of the compressed layer was reduced to about 65 per cent of the loose layer. A 5-ton roller was used.

The traffic on the experimental road, when counted in September and October of 1926, ran from 605 vehicles to 1,402 vehicles on different days, with some variation at different points on the road. But, in any case, the traffic was sufficiently heavy to give ample wear for test purposes. A check-up in November, 1927, showed no failures, although failures had occurred in the adjoining sections.

The only objectionable feature proved to be a strong glare in the sunlight. This could be reduced, of course, by the addition of sand in the mixture. At the present time, however, it is believed more feasible to apply a seal coat of asphalt with a squeegee machine and cover with a thin layer of coarse sand or pea gravel.

On the strength of this experiment and previous experience with shell, plans have been made to build a considerable mileage of shell-asphalt during 1928. This will consist usually of a course, 1½-in. or more thick, laid hot, as described above, as a new wearing surface for worn gravel.

Good Roads Helpful in Rural School Development

The widespread improvement of rural roads of all classes has aided in developing certain types of rural schools, notably the junior high school, according to Emery N. Ferris, Professor of Rural Education at Cornell University.

In his recent report, issued by the U. S. Bureau of Education, he notes that reliable means of transportation have greatly extended—in fact doubled—the distance from which schools can be reached by pupils. This has made it possible to develop three or four-year junior high schools, in many small centers unable to support four-year high schools, older pupils going daily to adjoining communities having high schools which serve several small communities.

There are now 1,174 centers of population under 2,500 having junior high schools. As a direct result of our modern road program, a million children in farm homes have more regular attendance, longer school years, and one, two, or even three more years of advanced public schooling than was within their reach a few years ago.

Highway Legislation Approved by Last Congress

Five major pieces of legislation, of interest to the motorists of the country, involving $239,200,000, were passed by the 70th Congress. Four bills, likewise of interest to the motorists, were left pending before various committees. One bill, viz., the Oddie-Colton bill, involving $10,500,000 for the construction of the gaps in the Federal-aid highway program, failed by virtue of the president's veto after being passed by the Senate and House.

The five measures which passed were the $165,000,000 Federal-aid bill; the $66,000,000 automobile excise tax elimination bill; the $4,200,000 appropriation for the Mt. Vernon Memorial Highway; the $4,000,000 flood relief measure for reconstruction of Federal highways in the states of Vermont, Kentucky and New Hampshire, and the Oddie amendment to the Federal Highway Act. The amendment marks the first step that the Federal Government has taken in beautification of the Federal highway system. It authorizes the planting of trees along the Federal-aid route, and provides that the Federal Government shall share with the states on an equal basis, the original cost of tree planting and maintenance.

The four measures which are now pending before various committees, and which will be considered further at the December session include the Browne-Watson bill, which authorizes a special highway fund of $407,341,000 and which, it is estimated, will speed up highway construction in the United States. The second is the Du Pont-Rathbone bill, which provides for the construction of a 500-ft. highway across the United States, to be financed by the leasing of business sites throughout its 3,000 mile length. Federal regulation of interstate motor bus traffic will be taken up again early in December, according to Congressman James S. Parker, author of the bill. The fourth measure, which did not reach a final vote, was a $1,000,000 appropriation for the widening of the National Defense Highway, linking the nation's capital with the Naval Academy at Annapolis.

In addition to the bills passed, three joint resolutions were adopted, the first authorizing a $15,000 appropriation to send American delegates to the Second Pan-American Congress on Highways at Rio de Janeiro; the second authorizing $25,000 expenditure for the Federal Government to entertain delegates to the Permanent International Association of Road Congresses, which will holds its sixth session in the United States in 1930, and the third authorizes the appointment of a commission to study the construction of a North American Highway traversing North, South and Central Americas.

Subgrade Treatment Before Paving

Experiences in Ontario Outlined at 14th Conference of Ontario Department of Highways

By H. C. ROSE
Engineer, Toronto and York Roads Commission, Toronto, Ont.

THE necessity for equipping a light traffic road for heavier service is one of the most common problems of the county and township engineer. With the increased speed limit and the remarkable increase in motor traffic during the past few years, we find that our roads of ten and even five years ago are totally inadequate to withstand the present day requirements.

A road, to satisfactorily carry traffic, must be constructed from the bottom up, and no type of wearing surface, no matter how expansive and well built it may be, will function efficiently unless laid on a firm and unyielding subgrade.

The wearing surface of a road fulfills three very important services:

(1) It withstands the wear and tear of traffic.
(2) It protects the subgrade by preventing the penetration of moisture.
(3) It distributes the load of the traffic over the subgrade.

In other words, the load of the traffic is ultimately borne by the subgrade and the success or failure of the pavement depends to a large extent on the bearing power of the sub-soil. Therefore, any assistance and improvement given to the subgrade will be accomplished by a corresponding increase in the strength of the whole pavement.

Drainage of Subgrade.—It therefore follows that the subgrade must be drained and kept drained at all seasons of the year, and both surface water and ground water taken care of and controlled. The surface water is taken care of by building a crown in the pavement and constructing adequate open ditches which will carry this surface water to natural outlets along the highway. Ground water may be controlled very efficiently by the installation of longitudinal tile drains, say 6 in. in diameter, laid to a proper grade just outside the edges of the pavement and carried to a satisfactory outlet. Where isolated springs are discovered in the subgrade, or soft spots develop, a center line tile installed longitudinally in the subgrade will usually function more efficiently than a number of short herringbone drains. This center line drain can be connected to one of the side drains, thus eliminating the numerous outlets occurring in herringbone drains. It is also considered good practice to backfill the tile drains with about 6 in. of crushed stone or clean gravel immediately over the tile.

It is therefore reasonable to assume that, with the surface and ground waters taken care of, the subgrade and subsoil for a depth of approximately 3 ft. will remain comparatively dry, and the benefit to the pavement wearing surface and base more than justifies the compartively small cost per mile for this subgrade protection.

In the case of old gravel roads, the engineer is confronted with a sudden and alarming increase in maintenance costs to meet present day traffic, which makes it almost prohibitive to attempt to maintain the road as a gravel road, and the only practical solution is the construction of a permanent pavement. In the case of old macadam roads, while they may be in fairly good condition and have several years of life remaining, they are usually too narrow and too high crowned to satisfactorily serve for present day purposes.

Gravel Roads as Bases.—In preparing an old gravel road as a base for a permanent pavement, all changes in alignment and grade which are deemed necessary should be carried out, and any structures which are too narrow or too short should be widened and lengthened. Knobs and depressions which were no detriment to a gravel road would become serious if allowed to remain in a permanent pavement, and should be eliminated before paving is undertaken. Many gravel roads were constructed along the lines of least resistance, and are therefore very seldom in the center of the road allowance, with the result that certain changes and corrections in alignment are necessary in the preparation of a pavement subgrade. Culverts on the old gravel road would probably be off line, or too short, and it is simple and economical to extend these to conform with the new pavement. In the case of narrow bridges, these may be left to the near future for reconstruction, unless the structure is unsafe when it should be replaced immediately.

After the so-called heavy grading is completed for the purpose of improving the grade and the necessary improvements in alignment are made, the old gravel road should be scarified and reshaped to conform to the cross-section of the new pavement. During the reshaping any surplus material may be graded to the edges and used for building up the new shoulders. When the reshaping is completed, the subgrade is then rolled with a self-propelled roller weighing at least 10 tons. This rolling should be exceedingly thorough in order to obtain a uniformly dense and thoroughly compacted base. Watering the subgrade will greatly benefit the rolling, as it not only aids in consolidation, but also helps in detecting soft spots and depressions. These soft spots and depressions, which may develop from the rolling, should be filled and brought to grade with crushed stone or clean gravel. Too much stress cannot be laid on the thorough rolling and particular preparation of the subgrade, as in the case of some pavements, particularly macadam roads, any irregularities or unevenness in the subgrade will carry right through to the top course and seriously affect the riding qualities and appearance of the surface.

To Scarify or Not to Scarify.—In the preparation of old macadam roads as bases for higher types of pavements, particularly bituminous pavements, there appears to be a diversity of opinion among highway engineers as to the best and most satisfactory method of dealing with this condition. This diversity of opinion occurs particularly when the old macadam is narrow and high crowned. Some engineers advocate the complete scarifying of the old high crowned macadam and grading and reshaping the scarified material to conform to the new cross-section and wider width required. Other engineers claim that the old road should not be disturbed in any way, but that the edges of the old stone should be excavated to the required width and fresh stone rolled in to sufficient depth to decrease the former high crown and give the required cross-section. Advocates of the first mentioned method claim that the new stone rolled into the edges cannot possibly be consolidated to the same degree as the old road, and that therefore the newly constructed edges are bound to settle to a greater or less degree and cause a variation in crown in the new surface. Undoubtedly this problem depends a great deal on local conditions and on the type of new surface to be constructed. For that reason it is probably advisable to deal with each particular paving job on its own merits and not attempt to lay down any definite rules which would be applicable under all conditions and locations.

Preparation of Subgrade for Concrete Roads.—Careful and particular attention to subgrade preparation is probably of more vital importance in cement concrete pavement than in any other type of pavement constructed. Other types of pavement, particularly the bituminous types, are more or less flexible and elastic and have self-binding and self-healing properties, which automatically repair in warm weather any ordinary fractures or cracks which have been developed. But cement concrete, being absolutely rigid, tends to develop cracks with even the slightest variation or settlement in the subgrade, and these cracks will not heal again but tend to become worse unless immediately filled with bitumen in order to protect the edges and keep out moisture. The subgrade should, therefore, be consolidated to a uniform density in order that any subsequent settlement in the sub-grade will be as uniform and even as possible, thereby reducing possible cracking to a minimum.

General Operations on The James River Bridge Project

Methods Described Before American Society of Civil Engineers

By H. B. POPE
Superintendent of Operation, Turner Construction Co.

THE James River Bridge project, a highway bridge that will span the water areas between Norfolk and Newport News, Va., is logically divided into several different classifications. In the first place, we have the James River Bridge, 23,771 ft. long and its approaches on both the north and south shores. This bridge can be further subdivided into first the pile trestle, second the deep water pier work which will carry the structural steel trusses, third the structural steel work itself and fourth the road approaches.

The second general classification would be Chuckatuck Creek Bridge, 2,396 ft. long. This bridge is primarily pile trestle construction, with a bascule lift span giving a clear opening of 90 ft. in the channel. We also have in connection with this bridge the necessary approaches and connecting roads.

The third main subdivision is the Nansemond River Bridge, 3,761 ft. long. This is also primarily of pile trestle construction and likewise has a similar bascule lift span in the channel.

General Layout.—The project starts at Warwick Road, about a mile and one-half north of the Newport News Ship Yard, in Newport News. We have a short approach to the river from this road of about 1,800 ft. We now have a short sand-filled timber bulkhead of 750 ft. before we start our pile trestle bents. Approximately ¾ mile off shore the four 90-ft. plate girder spans start. These are supported upon pile bents, then we have four 210-ft. truss spans. Then comes the draw span, which is a straight vertical lift, giving a clearance of 250 ft. between piers and a clearance of from 53 ft. above mean low water in its closed position to 148 ft. above mean low water when open. On the other side of the draw we have the same number of 210-ft. spans and 90-ft. spans as on the north side.

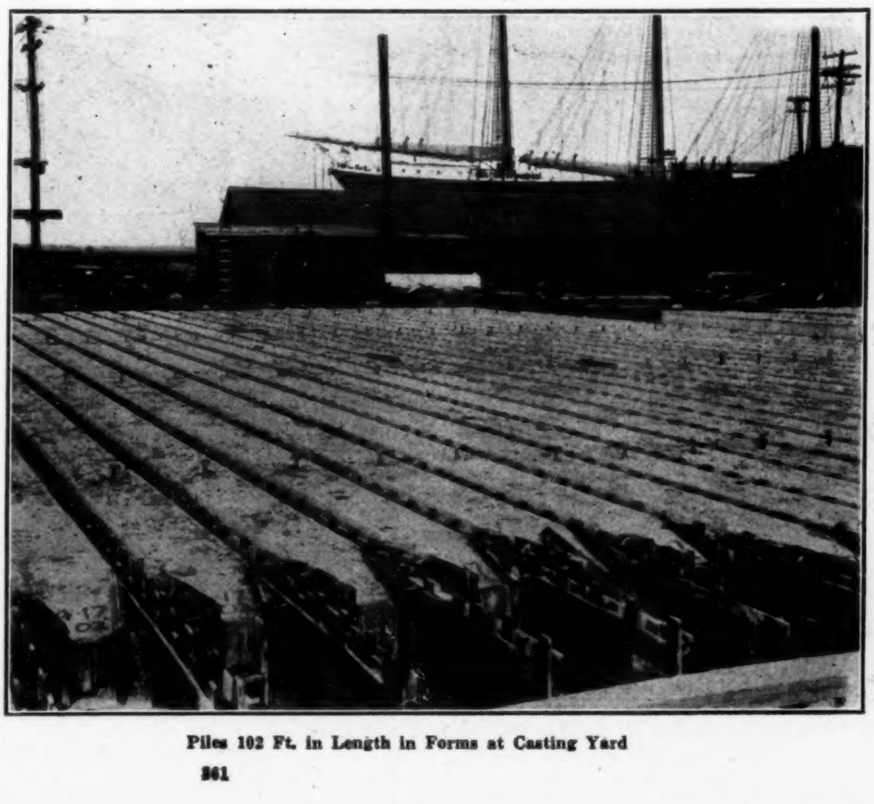
For a distance of approximately ¾ mile we have the typical pile trestle spans, then we have a group of plate girder spans which will furnish an opportunity for small boats to pass on the south side of the river. After this group of 90-ft. plate girder spans the typical pile trestle is taken up again and carried to a distance of 1,500 ft. from the south shore, where we resume the sand-filled timber bulkhead.

Paved Approach.—From the south shore of the James River to the old county road there is a distance of approximately 12,800 ft. which will be graded and surfaced, where practicable, with concrete, and on the long fill through the swamp located here a penetration roadway will be placed with provision for a permanent roadway to be placed later after the fill has properly settled. We then follow along the county road as shown until we reach the north end of the Chuckatuck Creek Bridge, where a short bulkhead and some new roadway will be required.

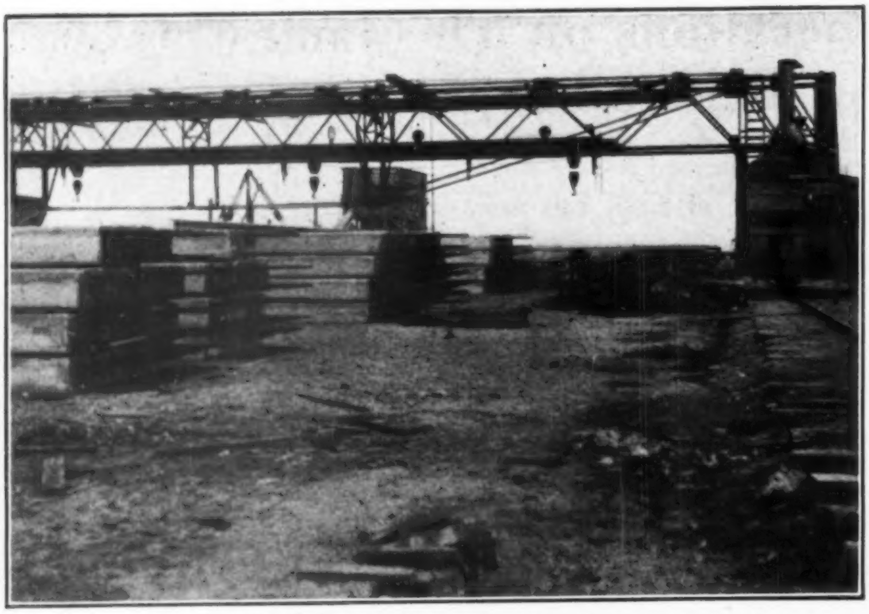
After crossing the Chuckatuck Creek, just west of the town of Crittenden, there is a short section of new road until we hit the county road running from Crittenden to Chuckatuck. We follow this road for approximately 2,500 ft. and then branch off to the left with about a mile of new road before we reach the Nansemond River. South of Nansemond River a new road will be constructed to where we meet the hard surface road running between Churchland and Drivers at a point just a little west of the Bennets Creek Bridge. In general all these roads will be concreted where there is no danger of the fill settling and ruining the concrete road.

Contractors.—Turner Construction Company, with main offices in New York City, was selected by the James River Bridge Corp., and by the J. E. Greiner Co., Engineers, of Baltimore, as general contractor for this work; they have in turn sublet to the Raymond Concrete Pile Co., of New York, the making and driving of all concrete piles; to the Sanford & Brooks Co., of Baltimore, the driving of piles, construction of cylinders, and in general all deep water work in connection with the piers for carrying the 210-ft. truss spans; and the draw span on the James River Bridge.

The structural steel work for the whole job, consisting of plate girder spans, truss spans, lift span and bascule spans, has been let to the Virginia Bridge & Iron Co. The road work has been awarded to the Roberts Paving Co., of Salisbury, Md. The Turner Construction Co. will exercise general supervision of all the above work and with their own forces will cap all piling as driven by the Raymond Concrete Pile Co., place the foundations for the bascule piers, place I-



Piles 102 Ft. in Length in Forms at Casting Yard



Gantry Used to Handle Pile at Casting Yard, With Piles in Storage

beams, and take care of all work in connection with the bridge deck.

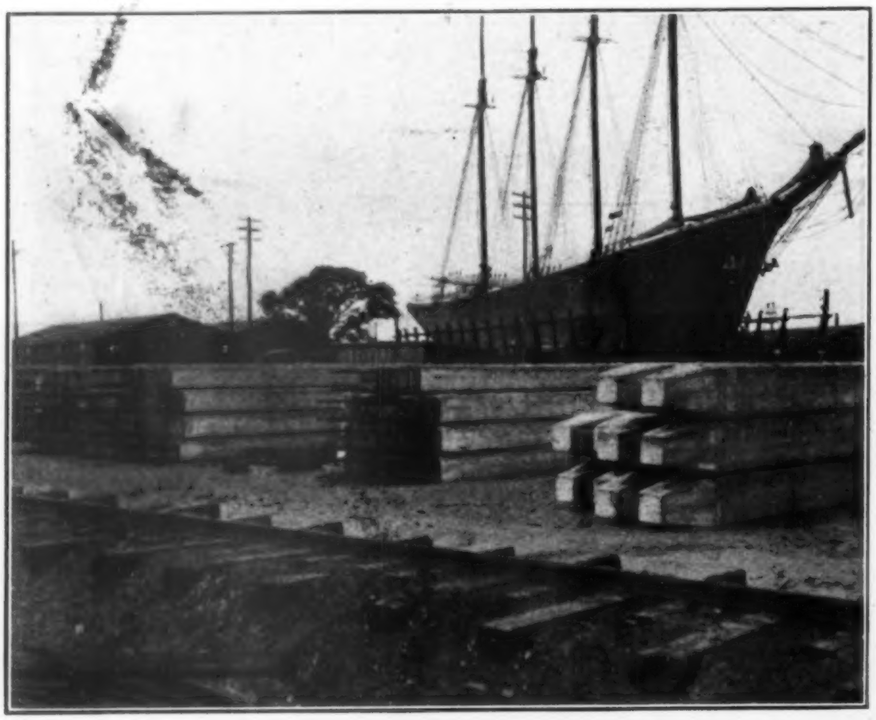
Pile Casting Yard.—At the start of the work a big problem was a proper location for a casting yard for the Raymond Concrete Pile Co. This can be readily understood when it is realized that Raymond must cure their piles for at least 30 days before driving, and with a production schedule of over 100 piles a week this requires a considerable area, as well as the area required for the actual casting of these piles. It was necessary that a long straight stretch be obtained with water facilities so that Raymond could erect their gantry, which running over the casting yard can pull the piles already cast, store them, and after curing, load them upon barges for transportation to the work. We were fortunate in obtaining a piece of property belonging to the Southern Shipyard Corp., adjacent to the small boat harbor at Newport News. This property has water on the east, south and west sides.

Yard Layout.—We have negotiated with the Chesapeake & Ohio R. R. and had them place railroad tracks as shown. The track here at the west side we are using for unloading our I-beams, incidentally these are 44-ft., 30-in., 115-lb I's. Just east of this track we have placed another track, alongside of which is located our reinforcing steel yard with power cutters and bending benches, on the other side of this track we are unloading lumber and have set up a saw mill and are using this location for making forms. Then comes Raymond's gantry track, storage and casting yard, and over against the east bulkhead is Raymond's concrete plant with storage piles and stiffleg derrick for handling sand and gravel from barges to the storage pile and to the bin. Then along this east bulkhead we are establishing an emergency storage pile of both sand and gravel to take care of our operations and also to take care of Raymond's requirements in case of break down or shut down at the gravel pits.

Casting Yard.—Raymond's casting yard is constructed on 2x4-in. stakes driven into the ground, these stakes are spaced 18 in. apart, running lengthwise of a supporting 2x4-in. joist, and these joists are spaced 15 in. apart. On the top of the joists ⅞-in. sheeting, the width of the pile, is laid and the side forms of the pile are placed abutting this bottom on either side. These side forms are held apart at the bottom by a 2x4, nailed to the joists, and at the top are braced and centered by means of a specially constructed removable cap member, which is taken off after pouring to permit the side forms to spring apart and thus allow the pulling of the pile. All piling has 3-in. bull nose corners. The casting platform has a capacity of 140 piles. Of these 100 are 24 in. square and 40 are 18 in. square. Piles up to 115 ft. can be made by putting the end stoppers in the desired location. They are now making piles ranging from 45 ft. to 115 ft. in length. I believe these 115 ft. piles are the longest concrete pile ever cast, and they weigh about 35 tons.

Raymond's Mixing Plant. — Raymond's mixing plant is thoroughly up to date. It consists of 2 mixers, fed from a large charging hopper holding approximately 400 yd. This hopper is filled by a stiffleg derrick; all material is measured by batch hopper and the water content of the concrete is accurately measured by an approved measuring tank; cement is delivered to the mixing platform from the cement storehouse by means of a roller conveyor. These mixers are electrically driven and are 1 yd. capacity each, giving us a daily capacity of over 300 yd. using a 2-minute batch.

Concrete Barge.—For our purpose in pouring the caps and slabs we have constructed 2 concrete mixing plants. These are built on barges 36x91 ft. in size and the mixing plant in general consists of a stiffleg derrick set at the rear end of the barge. This derrick carries a 58-ft. boom and is used for picking up sand and gravel from barges



Another View of Piles in Storage

Deck Reinforcing Supported by Precast Concrete Blocks

alongside and placing this material in a storage bin located at the front end of the barge over the 1-yd. mixer, which is installed on deck. The cement is brought to the mixing platform from a cement barge fastened at the rear of the concrete barge by means of a roller conveyor and we will have a storage of cement on the barge fastened at the rear of the concrete barge by means of a roller conveyor and we will have a storage of cement on the barge of approximately 250 barrels. The water for mixing purposes is pumped from the water barge along side through a circulating system on the concrete barge itself. By means of a well hole in the deck of the barge directly in front of the mixer we are permitted to drop our bucket below the deck to receive the concrete as discharged from the mixer. It is then hoisted up the tower and dumped into a storage hopper on the face of the tower. From this point the concrete is lead by chutes into the forms or into a portable hopper on the bridge deck as may be desired.

Gasoline Engines.—All equipment on this barge is gasoline driven. There is an 80-hp. Waukeshau engine for operating the 3 drum hoist and swinging engine of the stiffleg derrick. We have a 60-hp. engine for driving the mixer and operating the concrete hoist; a 40-h.p. engine operating the anchor winches through a reduction gear; and a 15-h.p. engine for the belt conveyor. There is in addition to these engines a complete Delco lighting plant for operating lights and flood lights on the boat; and also a small gasoline driven pump, which together with a 2,000-gal. water storage tank on the deck of our barge will take care of our water requirements at times when the water barge is being loaded. For any winter weather work we also have a steam boiler for heating water and aggregate.

Piling Steel.—Raymond's reinforcing steel in full lengths up to 117 ft. is brought in on the railroad track running in front of the Turner job office and unloaded at the extreme north end of the casting yard. It is carried by the gantry crane to the make-up yard and here the pile cages are made; the 24-in. piles have eight 1⅛-in. bars in each pile, while the 18-in. piles have but four 1⅛-in. bars in each pile. The hoops on the pile cages are ¼ in. round spaced 12 in. on center, except at the driving end and at the point where they are located much closer together. The longitudinal steel projects through the driving end at least 2 ft. 6 in. to permit the bonding of the cap to the pile, and these bond bars are taken care of during driving by means of a specially constructed driving cap with holes in it for the bars. After the cages are made they are picked up by the gantry and carried to the form where they are placed and centered, being supported at required intervals by small concrete blocks.

Closeup of Finishing Machine Used to Finish Deck Structure

Concrete Design.—The concrete used in the piles is mixed as dry as it is practical to work and will normally have a slump of from 4 to 5 in. The gravel used is standard 1-in. gravel from the Norfolk Sand & Gravel Co., with a grading factor of about 6.5, the mix used in the piles is a 1 to 4½ and the cement factor we are now using is 1.75 bbl. per yd. We are obtaining the strength of 28 days of about 4,500 lb. per sq. in. and the concrete is very dense, weighing on an average of 148 lb. per cu. ft. Absorption tests show very little water absorption, although no waterproofing of any kind is used in the concrete. After the piles are poured, and incidentally it might be well to say at this time that during cold weather the water used for mixing purposes is heated, they are protected by means of canvas thrown over the forms and are kept warm by means of live steam lines running underneath the casting platform.

Stripping Piles.—In order to facilitate the pulling of the piles from the forms 3 or 4 1⅜ T-bolts are cast into the piles; the number of T-bolts used depending upon length of the piles. After 7 days the gantry crane is placed over the pile to be pulled and by means of these T-bolts the pile is raised from the form and carried to the storage yard. The load lifted on each T-bolt is equalized by means of equalizing blocks on the gantry so that there is no danger of getting an excessive load at any one point and thus cracking the pile. After the piles are placed in the curing yard they are cured by means of water jets and thoroughly inspected for cracks and flaws. The T-bolt is now screwed out, the nut and washer at the bottom being left in the pile and the hole is filled with a mastic.

A very careful schedule of the requirements so far as pile lengths are concerned was worked out from boring records on all the rivers, and although in practice we are finding the necessity of some change in pile lengths the results as a whole have been satisfactory.

As the piles are required for the various bents they are picked up from the curing yard by the gantry crane and loaded on to large flat barges for transporting to the drivers.

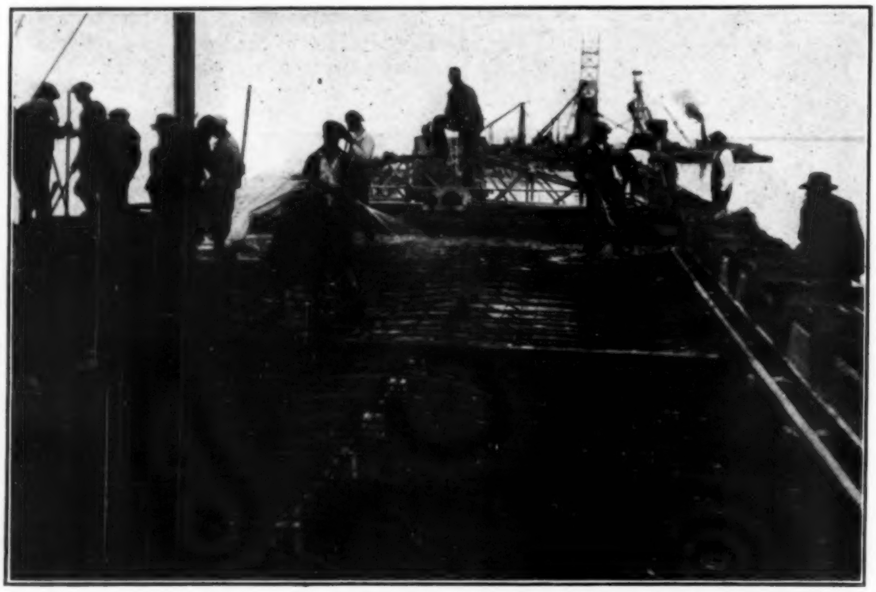
Main Base.—In addition to Raymond's casting yard, we have our main base of operations at the Southern Shipyard. The Turner Construction Co.'s main job office is located here. There is also a very complete testing laboratory where tests are made of concrete aggregates; and 7 and 28-day tests of concrete as poured daily are made from samples of concrete taken from the piles as they are being cast. As the piles are capped and the deck slab is poured these tests will be continued, forms on deck to be stripped according to strength of samples.

We are also using the boat harbor at the east side of the property as a fitting up yard for our various equipment, particularly for our floating concrete mixing plants. Our form yard is fitted up in an up-to-date manner with power saws, electric drills, portable handpower saws and in general we have a form manufacturing plant, as is, of course, required to economically construct the vast amount of forms which are required on this job.

We are also building in the yard some small barges, 16x26 ft., which will be used for stripping and pile capping purposes.

Triangulation.—As you can readily understand, one of the big problems which we encountered at the start of this job was the proper location of the various portions of the work. In other words we must locate accurately the bascule piers on the two small bridges, the deep water piers on the James, and all of this must be done with nothing but water to work on. We have found it necessary to build up a rather elaborate triangulation system, particularly so far as the James River was concerned on account of the vast distance encountered there. Mr. O. M. Heaton from the U. S. Coast and Geodetic Survey laid our original triangulation net work and this system has been supplemented by Mr. Kendall of the U. S. Geological Survey. We have then driven temporary platforms at strategic positions and have located these by triangulation and checked their relative positions as well as possible by means of tested tapes. By means of these platforms we are in a position to start driving piles at any desired location and to make a closure without fear of any great error. This problem of location of work has been one of the most interesting, as well as one of the most difficult, in all of our preliminary work.

Dredging.—In the actual construction we were forced on account of the shallowness of the water near shore on all three bridges to dredge a channel 180 ft. wide from the main river channel to the shore at the bridge locations. Sanford & Brooks have the contract for this dredging, which will amount in all to over 290,000 cu. yd. These channels are dredged to a minimum depth below mean low water of 6½ ft.



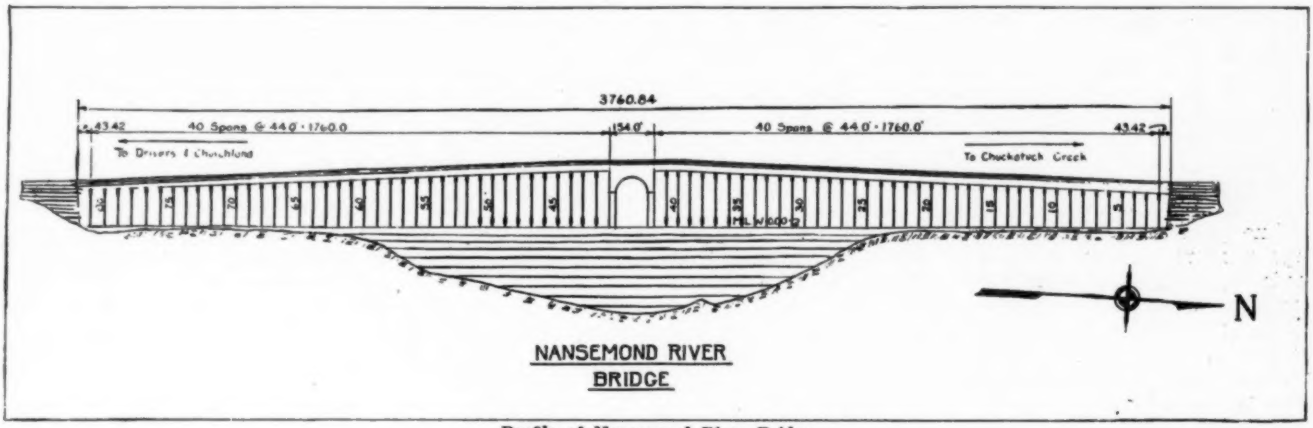
Deck Reinforcing in Place; Finishing Machine Used on Concrete

Summary of Quantities on Project

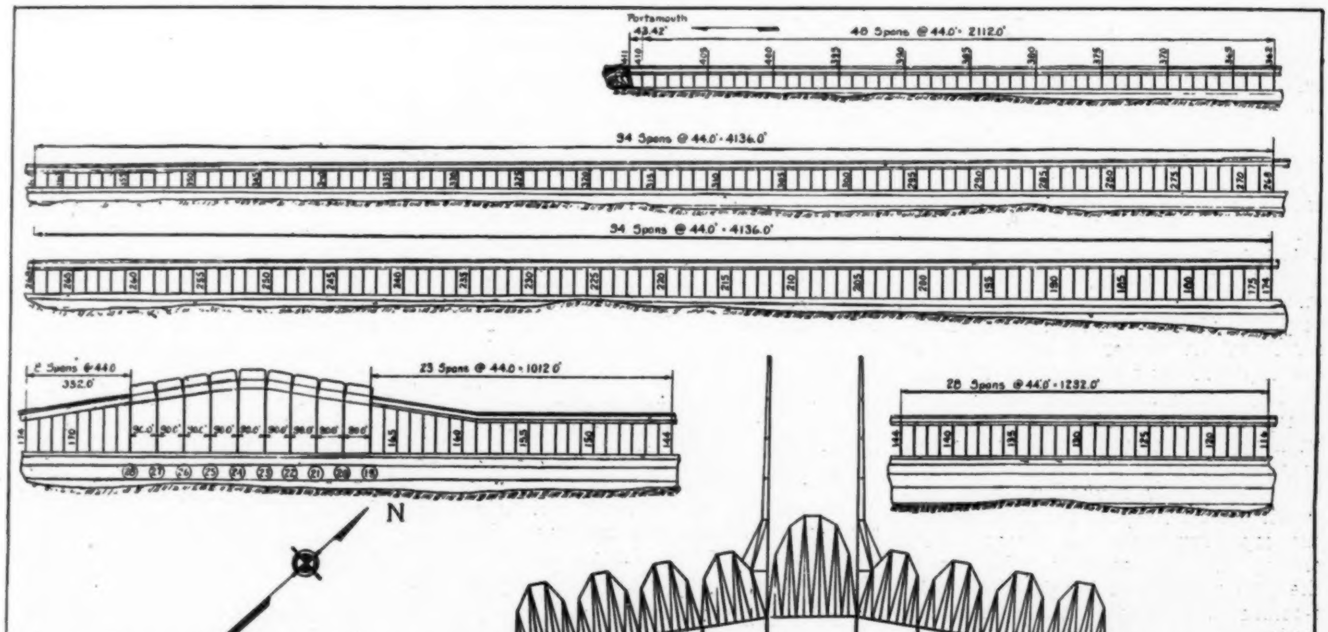
LENGTH OF BRIDGES:		
	Lin. Ft.	
James	23,771	
Nansemond	3,760	
Chuckatuck	2,397	
Total lin. ft.	29,928	=5.7 miles
NUMBER OF CONCRETE PILES:		
James	1,968	
Nansemond	460	
Chuckatuck	324	
Total number	2,752	
NUMBER OF CONCRETE PILES DRIVEN:		
Nansemond, complete	460	
Chuckatuck, complete	324	
James	284	
Total piles driven	1,068	
CUBIC YARDS CONCRETE IN PILES:		
Total cu. yd.	24,835	
TONS REINFORCEMENT STEEL:		
Total tons	4,572	
TOTAL YARDS OF CONCRETE:		
Total cu. yd.	66,425	
TOTAL TONNAGE OF STRUCTURAL STEEL:		
Total tons	8,932	
TOTAL NUMBER OF MEN EMPLOYED:		
Total men employed	670	
AMOUNT OF MATERIALS ON BRIDGES:		
Sand, cu. yd.	30,000	
Gravel, cu. yd.	57,000	
Cement, bbl.	107,000	
AMOUNT OF MATERIALS ON ROADS:		
Sand, cu. yd.	12,800	
Gravel, cu. yd.	24,200	
Cement, bbl.	40,000	
TOTAL CAR LOADS FOR ALL MATERIAL:		
Sand	1,700	
Gravel	3,600	
Cement	640	
Reinforced steel	150	
Structural steel	200	
Lumber	65	
Total cars	6,355	

and by means of them Raymond is enabled to float their driving equipment into exact location and we are able to use a floating concrete plant for all our work.

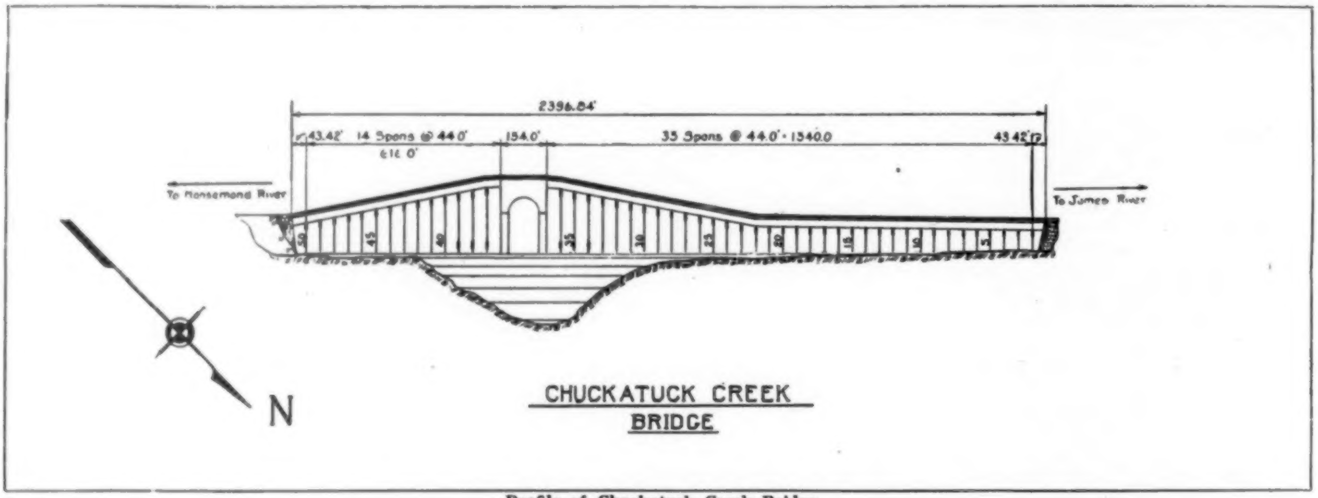
Pile Driving.—The equipment that Raymond is using for driving their piles consists of two large drivers; one is a driver having 4 leads and 2 hammers, the other driver is a single lead driver of standard construction. On the 4-lead driver, which is to the best of my knowledge the only one of its kind in the country, there is located a huge derrick capable of handling over 35 tons. This derrick will pick up the piles from the barges and place them in the loads; the derrick then picks up each of the two 7,500-lb. steam hammers, which are built into a sliding assembly, and places them in the leads on top of the piles already spotted. By means of this rig they can spot 4 piles at a time and drive 2 piling simultaneously. When this 4 lead driver is gotten in the proper position for driving it is held in place by means of 4 spuds lowered into the mud; this also prevents the barge from canting when the heavy loads are picked up. The 4 leads are all fastened together and can be moved as a unit in any direction a limited distance without moving the barge itself. This permits very accurate spotting of these piles, incidentally all of this spotting is done by means



Profile of Nansemond River Bridge



Profile of James River Bridge and Approaches



Profile of Chuckatuck Creek Bridge

of line given with an instrument with tape measurements for stations. These leads without head block permit the use of an extremely long pile without having pile driving leads which would be excessive in height, the use of the derrick eliminating the necessity of the standard head block.

Dolphins.—In all of the rivers we are having to drive dolphins and fender piles; the dolphins for tying up of equipment and the fender piles to prevent equipment anchored close to the bridge from damaging the bridge itself while same is under construction.

Pile Trestle.—In general, as has been described by Mr. Ballard, all pile trestle bents are of 4 piles, the size of each pile being 18x18 in. or 24x24 in., depending upon the overall length and unsupported length. In most cases, however, this unsupported length of piling is such that a concrete cap can be placed directly upon the piling themselves at the proper elevation so that the cap directly supports the I-beams. In deep water, however, we must place a cap near the surface of the water on account of this unsupported length of pile; when this last is done columns are erected with supporting walls between them on top of the pile cap and the cap supporting the I-beams goes on top of these columns. On top of the pile caps run 4 longitudinal 30-in. I-beams 44 ft. long with provision also made for expansion; over these I-beams is placed a deck slab which is 9 in. in thickness, reinforced in general with ⅝-in. round iron. We are expecting to use a road finishing machine for giving our deck slab a first class finish. This machine will run upon specially designed track resting on the I-beams and will eliminate all hand finishing of the surface, except for the curbs and for that portion where the track carrying the finishing machine is pulled out after the machine has gone over the surface.

I-Beams.—After the caps are poured and anchor bolts placed with bearing plates, the I-beams will be loaded on to a derrick scow at our yard, taken out into the river and placed in position, with this same derrick scow. The form work will then be placed and the slab poured, after which it will be cured by means of flooding or by damp sand for a period of at least a week.

Deep Water Piers.—We now pass to the foundations for the deep water piers, those for the 210-ft. truss spans are supported on wood piling. On top of the wood piling are placed steel cylinders, 2 for each pier running from the bottom of the river up to required grade of plus 4 ft. above mean low water. These cylinders are belled 23 ft. in diameter at the bottom and reduced in size to 10 ft. at the river level. The foundation for the James River lift span is 28x52 ft. at the river bottom, but after a tremie concrete seal 15 ft. thick is poured inside a steel sheet pile cofferdam around these piles this cofferdam is pumped out and the piers themselves are started on top of this seal. In the cylindrical foundations, under the 210-ft. trusses, there is also a tremie concrete seal poured to minus 10, after which they are unwatered and the remainder of this foundation is poured.

I would like to elaborate a little on the method of under water work after the piling have been driven, and some of these must be driven with a tube on account of their short length. We thoroughly inspect the condition of the piling by sending a diver down and it is also this diver's duty to be certain that the cylinders are set accurately over the piling and that there is no piling left outside of the cylinders. The diver has a very interesting job with a 3-mile tide running and plenty of piles to get fouled up in; every now and then he comes up upside down, having gotten tangled up in his life line.

Equipment.—A slight idea of the equipment required for this job is as follows: Sanford & Brooks have 3 pile drivers, 2 derrick scows, floating concrete plant, 2 tugs and a dredge working, as well as necesary launches and barges. The Raymond Concrete Pile Co. have 2 pile drivers, 2 tugs, water boats, concrete pile barges and several launches working. Turner Construction Co. has not yet really started their work, but we will require and have under charter about 20 power boats of various sizes, as well as our concreating scows and about 12 barges for stripping purposes and for carrying material. In order to facilitate the transportation problem we have purchased a sea sled which will enable us to get around the job for inspection purposes at a speed of about 25 miles per hour. The desirability of this speed can be realized when we consider from the Southern Shipyard base to Nansemond it is about 8 miles; it is another 6 miles around the bar to Chuckatuck and then perhaps 8 miles from Chuckatuck to the James River Bridge and then 5 miles back home again.

Transportation.—So far as transportation of men is concerned this will be a big problem getting them to and from work. From the Nansemond River to the Chuckatuck Creek the distance is short enough to require comparatively little transportation, except as furnished by the men themselves getting to and from the river bank. We are endeavoring to upset present labor conditions in this district as little as possible.

Organization.—Mr. R. C. Wilson, Southern General Manager for the Turner Construction Co., is in charge of this whole operation; Mr. D. M. Bartlett, General Superintendent of the Southern District, is in direct charge; Mr. H. B. Pope is Superintendent of the operation; Mr. H. W. Roberts is General Purchasing Agent and Office Superintendent; Mr. G. B. McGraw is Superintendent in charge of the work being done by the Raymond Concrete Pile Co.; Mr. Raymond Matthews is Superintendent in charge of work being done by Sanford & Brooks; the J. E. Greiner Co. is represented by Mr. Wilson T. Ballard, a member of the firm. Mr. William Willoughby is Resident Engineer on this work.

The Bond Issue Plan of Road Building In North Carolina

A Review of One State's Experience With Highway Bond Issues

By ANGUS W. McLEAN
Governor of North Carolina

NORTH Carolina's highway system embracing 7,700 miles, of which one-half has been hard-surfaced and the remainder improved according to other modern methods, at a cost of approximately $140,000,000 has not imposed and will not impose any burden whatever upon property owners. With the exception of the amount received from Federal aid, local contributions and the surplus derived from ordinary income, the system has been built through funds obtained by bond issues, the interest and principle of which is being paid by the users of motor vehicles upon the highways.

The receipts from taxes upon gasoline and motor vehicle licenses are sufficient to pay: (a) the cost of administration of the highway system; (b) interest on all outstanding highway bonds issued and authorized; (c) sinking fund and serial payments, for retiring the principal of all bond issues within a period of 25 years from the present time; (d) full maintenance of the entire highway system according to the most improved standards, and (e) to produce a surplus for additional construction of about $5,000,000 annually.

North Carolina's method of financing the building of State highways largely upon the bond issue plan is economically sound and no valid objection can be made thereto.

Approved by Citizens.—The State started its real road-building program in 1921, when the General Assembly provided for a $50,000,000 bond issue for the construction of a "system of dependable highways connecting every county seat and principal city in the State." This action was the result of a well-conducted program of publicity bringing out the needs and showing how the plan could be financed without placing a burden on any taxpayer. The advent of the motor vehicle and its use in the rural sections, as well as in the cities and towns, helped to prepare the public mind for the State highway system.

Such remarkable results were obtained by the North Carolina Highway Commission, composed of a chairman and ten members from as many districts into which the State was divided, that the people were ready to back up additional bond issues at each successive biennial meeting of the General Assembly to extend the roads and enlarge the system. The 1923 session provided for a $15,000,000 bond issue, that of 1925 a $20,000,000 bond issue and the last session, in 1927, added $31,850,000 making a total amount of $116,850,000. Because of this available money, North Carolina was able to secure, in part, apportionments from the Federal Government during the period since 1921 and including that of 1928, estimated at approximately $11,000,000.

"Pay As You Ride" Plan.—One of the chief arguments in favor of building roads rapidly by the bond issue plan is that the use of the road pays for its construction. The man who operates an automobile pays an average of $32 annually to the State in taxes, approximately half of which is the annual license tax, the other half being a four-cent tax on gasoline he consumes. Instead of following the "pay as you go" plan, we have found it much more satisfactory to "pay as you ride".

The fact that we have large sums of money available for road construction is important in attracting prominent road building contractors from other sections. This offers unusual competition, naturally reducing the price at which we have purchased our labor and material, and materially decreases the overhead charges, upon completion of the program.

Probably no more striking value of the bond issue plan of road construction can be found than in the 300 per cent increase in the number of automobiles operated in North Carolina during the six years since the highway program actually started. In 1921, when the first $50,000,000 bond issue was authorized, the registration of motor vehicles in the State was only 135,000. The number registered in 1922 was 166,000; in 1923, it was 211,000; in 1924 the number reached 288,000; in 1925, it was 341,000; in 1926, 384,000, and in 1927 the registration reached 434,000. Of course, a normal increase in the number of automobiles was expected, but it is unreasonable to think that the number would have increased at such rapid rate if the State had built only a few scattered stretches of hard-surfaced roads on which they might operate. This increase has, of course, much more than doubled the income from taxes and is taking care of the interest and principal of the bonds issued, the maintenance of the system and, at the same time, provided approximately $4,500,000 last year for new road construction. This amount is constantly increasing.

Ample Revenue Available.—The bond plan had proved so satisfactory up to the time and the income was so much larger than had been anticipated, due to the unexpected increase in the number of automobiles, that the 1927 General Assembly provided that the North Carolina Highway Commision take over, in its discretion, an additional 20 per cent to add to mileage then composing the State Highway system. Up to this time about 1,000 of the 1,400 miles has been taken over and is being developed and maintained by the State Highway Commission, the remaining 400 miles to be added in due time. This permits a further rounding out of the State system and extending it so it will be of further service to the citizens in the remoter sections of the State.

—During the six years since the State highway act actually became effective in 1921, at the time the first big bond issue of $50,000,000 was authorized the State has received approximately $70,000,000 in gasoline and motor registration fees. In 1926 these taxes amounted to $13,616,925.58. During the last six months of 1927 (the General Assembly changed the automobile registration period of June 30-June 31 to conform to the calendar year) the receipts amounted to more than $7,000,000 The first three months of 1928 show gross receipts of nearly $8,000,000 the estimates of officials being that the total gross receipts for the year will reach $17,000,000.

North Carolina's first big move toward highway construction in 1921 came at a very opportune time. During that year and the next the country was going through agonies of the post-war deflation. Many of the industries and business that had been thriving were forced to close their doors and curtail their operations. North Carolina was enabled, because of the $50,000,000 bond issue that had been authorized early in that year, to throw herself into this breach, utilize the surplus labor in her highway construction program and thus keep this State in the "business good" class while many of the sections of the Nation were going through a strenuous two-year business depression period. This was a fortunate coincidence and is not directly related to the

bond plan of road construction, except that the money was available as a result to keep the State out of the depressing conditions experienced by the country generally.

Credit Structure Sound.—So far this discussion has dealt with the satisfactory results obtained by the bond plan of road construction. There is still another side, and a very important one, dealing with the methods and manner of paying off the bonds when they fall due and whether or not the bond issue plan is in keeping with sound business, particularly with reference to financing highway construction.

States and municipalities, as well as corporations and individuals, are entitled, undoubtedly, by every moral consideration to the beneficent boon of credit. Credit, as is well known, is the very foundation of sound finance. Corporations of all kinds resort to it for extending their activities, whether they be of a private nature, railroads or other forms of public service. In recent years increasing use of credit has been made by individuals and now Professor Edwin R. A. Seligman has come out in a notable defense of the installment plan of buying, as applied to the purchase of automobiles and other commodities in general.

The wisdom of borrowing is always passed upon by the lenders. If borrowing is justified in a given case, lenders will be found. Back of the credit of a private corporation must be values, assurance of continued earnings, upon a constant or increasing scale. On such a foundation, a private corporation is justified in asking and receiving credit. If a financial structure is well set up, if useless outlay is eliminated, if common sense is used in planning overhead, if a corporation meets the popular demand of quantity, quality and cost of its products, if its obligations are payable serially, or, are attended by adequate sinking fund provisions, if allowance be made for necessary up-keep and repairs, then a corporation is not only entitled to credit, but is entitled to get it at low interest rates and in generous amounts.

Strict Business Methods.—North Carolina has attempted to conform her borrowing to the principles which underlie successful borrowing by business corporations.

Beginning with the first important financial legislation for highways, in 1921, and continuing at each biennial session of the General Assembly, North Carolina has placed safeguards for the security of investors and the protection of the motor vehicles rate-payers, through conferences between experienced public officials and representatives of banking and investment interests. The Constitution of the State has been amended to place a limit of 7½ per cent, upon the total amount of State indebtedness.

The full faith, credit and taxing power of the State has been placed behind every bond and note issued. Revenues of the State from motor vehicle and motor fuel taxes have been pledged, as additional security to the bondholders. The gasoline tax of four cents a gallon is paid cheerfully and willingly by the citizens of North Carolina, as well as by many motorists from other states, who are glad to pay the tax for the privilege of driving over this State's splendid roads.

No payment is permitted to take precedence over the required payments from highway revenues upon the interest and principal of highway bonds and the sinking funds, except a small amount for highway administration, maintenance and the cost of collecting the revenues.

Maintenance is Important.—Since 1921 North Carolina has issued $95,000,000 of the $116,850,000 authorized and $11,850,000 bond anticipation notes for highway construction. The $10,000,000 bonds last issued, as well as the next $20,000,000 to be issued, mature in equal annual series within twenty years. The preceding $20,000,000 bonds matured annually from five to twenty-four years. The $65,000,000 bonds first issued, having a somewhat longer serial maturity, were further protected by the creation of a sinking fund of the rigid type, no payments being allowed upon the serial bonds from the sinking fund until the latter become sufficient to retire the entire $65,000,000, a point which actual computations show will be reached about 1953, or more than ten years before the last of the bonds mature.

By a legislative amendment in 1927, it was directed that it should be a part of the contract in the sale of every bond issued thereafter that highway revenues should never be used for construction purposes until, after setting aside sufficient monies for the debt service, a further sum be set aside "sufficient to maintain the roads of the State highway system for the ensuing year in a sound and serviceable condition." We realize in North Carolina that the maintenance of highways is of even greater importance than the construction of new highways. It is important to the State, and it is also important to the holders of the State highway bonds.

A State Sinking Fund Commission has been created, composed of the Governor, the State Treasurer and the State Auditor, all being under heavy penalties for the faithful performance of their trust. Investments of the sinking funds may be made only in bonds of the United States, bonds or notes of the State of North Carolina, bonds of any state whose full faith and credit are pledged, and bonds of counties, cities and school districts in North Carolina having certain minimum population, with the proviso that, except as to United States bonds and State of North Carolina bonds and notes, no securities can be purchased unless accompanied by the approving opinion of a recognized bond attorney. By the latter provision, it is believed that bonds purchased by the State Sinking Fund Commission may be readily sold at any time, and, therefore, no restrictions have been placed upon the maturities of bonds purchased. Adequate provisions are made for the registration of sinking fund securities in the name of the State, with corresponding provisions for the release and transfer of registered securities.

Bonds Marketed Carefully.—The policy of this State has been to purchase, for the sinking funds, bonds issued by the State and its more important political subdivisions and municipalities. This has a tendency to hold up the market for State and municipal bonds issued within the State.

We have realized the importance of preventing a glutting of the market for our securities. We keep a continuous watch on the condition of the market, in order to avoid offering our bonds for sale before earlier bonds have been digested. This restraint in making bond offerings in no way interferes with the road program, for the law authorizes the issuance of bond anticipation notes to anticipate the sale of bonds which have been fully authorized. These notes enter a very different market from the market which purchases long time bonds. They are readily salable at a low interest rate. On their maturity, they are paid by an issue of bonds, if the time has come for a bond issue, but otherwise are paid by a refunding note issue.

By such methods, North Carolina has been able to reduce the interest rate gradually on her bonds to four per cent.

One of the objections often heard to the use of State bond issues to finance its highways is the fear that, with such a large amount of money at their disposal, members of the highway commission would be tempted to indulge in extravagance and unnecessary work, or to favor certain sections of the State at the expense of others. It is undoubtedly true that haphazard work and planning consort very badly with a plentitude of funds. North Carolina realized that danger in the beginning, and before any bonds were issued had planned and marked off with great care a complete State system of roads, systematically laid out for the good of the people of the State as a whole, and yet with fair distribution of advantages to the district divisions of the State.

Able Business Management.—Direction of the construction and maintenance of a highway system must necessarily rest with a board or commission of ability and integrity, devoted to the good of the system as a whole, jealous of its good name and the good name of the State. North Carolina has been fortunate in having on its highway

commission a group of successful and solid business men, furnishing all of the qualities needed to make a success of the task they have brought so satisfactorily to this point. They have not been subject to criticism on grounds of favoritism, laxity in methods, loose handling of funds intrusted to them or in any other of the many criticisms to which public servants may be subjected.

It may be seen, therefore, that North Carolina's plan of road construction by bond issues has not only worked, but has proven entirely satisfactory. The plan has resulted in more than 7,700 miles of highways, almost half of which are hard-surfaced, forming a system that is being rounded out into a net work that meets with complete approval from the citizenship. The costs are being paid and the bonds are being retired in a manner that is not only not burdensome, but gives the motor vehicle users twice as much value as they pay in taxes. The increased number of motor vehicles and increased use of gasoline because of the good roads provides revenue that will retire all bonds as they fall due, provide for complete maintenance and add materially to the funds that are being used in new construction work.

Undoubtedly the bond issue plan has been 100 per cent effective in North Carolina, and it is not only approved by the people but by the investors in our securities.

Acknowledgement.—The above article is reprinted from the June New Mexico Highway Journal.

Concrete Pavement Opened to Traffic 20 Hours After Placing Last Concrete

By WALTER C. BUETOW
State Highway Engineer of Wisconsin

President Coolidge's sudden choice of a Brule, Wis., estate as his 1928 summer home gave our highway department the task of quickly putting the roads around Brule in first-class condition. In accomplishing this task, we established what we believe a record for opening portland cement concrete pavement to traffic by opening a section of U. S. Highway No. 2 20 hours after the last concrete was placed.

In the vicinity of Amnicon Falls on this highway, a 2-mile strip of concrete pavement was laid last year and the contract for an adjoining two miles was let for completion this summer. The president's decision, however, made it imperative that the road from his home to the executive office in Superior be improved immediately. Certain stretches of the road needing maintenance were patched, but one stretch just past the end of last year's pavement was in such condition that we decided to save the cost of temporary surfacing by paving immediately.

This decision was reached at 9 o'clock Monday night, June 4. Our highway engineers went on the job at 3:30 the following morning to stake out the paving, finishing by 7:00. An emergency grading crew completed their part of the job in time for forms to be set by noon. Placing the concrete started at 1:30, the last batch for the section was placed by 9:00 the same night, and the pavement was opened to traffic the following evening.

The concrete was proportioned, 1 sack of cement, 1¾ cu. ft. of damp bulked sand and 2½ cu. ft. of damp gravel. The water added at the mixer was held at 3.4 gal. per sack of cement which included 1 gal. containing a 2 per cent solution of calcium chloride. Moisture in the aggregate averaged about ½ gal. of water per cubic foot of sand, and ¼ gal. per cubic foot of gravel; this made the total water about 4.9 gal. per sack of cement. All of the concrete was mixed for 3 minutes, the mixer being equipped with an automatic timing device.

Slump tests of the concrete were made throughout the whole job, the slump varying from ¾ in. to 1½ in.

Eight test cylinders were made—three of these of concrete from the last section that was placed, and both the cylinders and the paving were cured under the same conditions. Of the two cylinders broken the day after the paving was completed, the older of the two (26 hours old) failed at 2.498 lb. per square inch; the younger (20½ hours old) failed at 2.047 lb. per square inch. As a result of these tests the pavement was opened to traffic immediately.

Five of the remaining cylinders were broken the second day after making (June 7), the remaining one being held for testing at 28 days. The results of tests are given in the following table:

Test Data of Pavement Cylinders

Cylinders Made on June 5	Cylinder Broken Date	Age in Hours When Broken	Unit Breaking Load
2:30 P. M.	6-6-28	26	2,498
3:45 P. M.	6-7-28	47¾	2,839
4:30 P. M.	6-7-28	47 1/6	2,701
5:30 P. M.	6-7-28	47 1/6	2,353
6:45 P. M.	6-7-28	45 1/3	2,672
8:00 P. M.	6-6-28	20½	2,047
8:00 P. M.	6-7-28	44¼	2,614
8:00 P. M.	Will be broken at age of 28 days		

We credit our success with high-early-strength concrete on this section to a properly designed mix and to care in following accepted methods of mixing, placing and curing. Control of the mixing water assured a constant water-cement ratio, and a mixing time of 3 minutes helped to increase the early strength, and workability of the concrete. Keeping the concrete damp insured rapid and proper curing.

Associated in planning and executing the work were Col. E. W. Sterling, representative of the White House, J. R. McLean, H. F. Holmes and Roy Risburg, all of the State Highway Department, and George F. Mork, field engineer for the Universal Cement Co. The concrete was placed by A. N. Nelson, contractor, Duluth.

Photographic Record of Construction

Convinced of its value, the New Mexico Highway Department has borrowed a practice adopted several years ago by the U. S. Bureau of Public Roads—namely that of securing of photographic record of Federal Aid construction. The New Mexico Highway Journal discusses this as follows:

The strict requirements and close supervision of the bureau on the one hand and the state's responsibility and contact with the contractor on the other, make it necessary for the state's engineers to obtain the most complete records of Federal Aid work. The camera furnishes the one means of securing a complete and indisputable record.

The engineer as he looks through his instrument visualizes the proposed construction in its relation to its topographic setting. His resulting notes are highly important, but lacking in perspective. The camera will obtain a record which can be visualized and understood by anyone—a record of inestimable value to the office man whose duty it is to interpret the engineer's notes.

Frequent controversies arise on construction work, such as earth classification, condition of the ground during bridge and foundation excavation, character of borrow pits, etc. Photographs taken during these operations will furnish a permanent, unbiased and incontestable record. Only recently such a pictorial record was taken as supporting evidence in the classification of earthwork on an entire Federal Aid project to the complete satisfaction of every party involved.

The engineers will be equipped with cameras and will obtain, in additon to the notes always required, a complete photographic record of each Federal Aid project from the time of its inception until its completion—and further, during the period of maintenance. The camera will become just as much a part of the engineer's standard equipment as the level or transit, and just as necessary.

Alcoholic Beverages to Be Taxed to Build Roads in Latvia.—A law which has just been approved by the Latvian Cabinet of Ministers provides for the imposition of a 3 per cent tax on all alcoholic beverages, to raise revenues for the road funds under the Ministry of Communications, according to Trade Commissioner Lee C. Morse, Riga, in a report to the Department of Commerce. For the imposition of this tax, the Tax Department shall fix average retail prices which are subject to the approval of the Ministry of Finance. The tax shall be collected simultaneously with the excise tax, and the whole revenue from the tax will go to the road fund.

How a State Highway Department Uses Machines in Its Accounting Work

Accounting Methods Described in North Dakota Highway Bulletin

THE reorganization of the North Dakota State Highway Department provided in the legislation enacted by the 1927 Legislative Assembly not only compels the installation of a budgetary system within the new Department of State Highways, but also renders necessary an accounting procedure to make certain that department heads live within the amounts granted them. In addition, unit cost information must be furnished so that the public will be advised from every angle just for what they are paying.

Revised Bookkeeping Methods.—The new State Highway Commission took office March 15th, 1927, and as soon thereafter as possible the work of revamping the business procedure was begun. It was first necessary to provide rules and regulations governing the use of highways by public utilities under indeterminate franchises to be granted by the commission and later to do a number of minor things rendered imperative by the change in organization. The first step in actual accounting revision was to provide some means to procure accurate and current cost accounts speedily. As the books of account of the maintenance division already were in excellent shape to supply the basis for cost data, it was only necessary to install some method or device to provide the information cheaply and promptly. To do this manually by clerks would require new and special books and a number of additional clerks. But, the greater the volume of business handled by humans the more likely are mistakes and errors. Therefore, some kind of a mechanical device which would not only be speedy, but also accurate, would provide the safer proposition. With the approval of Gov. A. G. Sorlie, Secretary Ermatinger arranged in July, 1927, for the installation of Hollerith tabulating machines, although the machines didn't arrive until September. They were invented about 1893 by Dr. Hollerith primarily for the U. S. Census Bureau in order to provide a speedy, accurate and cheap method of compiling U. S. Census data. Of course, the original machines were rather crude compared to the complicated and complete instruments of the present day. A combination of three machines compose the Hollerith group: An electric key punch for punching information upon a card according to a predetermined code; an electric sorting machine which sorts the cards according to the information sought; and an electric tabulating and accounting machine to compile the data selected by the sorter.

A Code the Basis.—To compile and analyze any form of data intelligently it is first necessary to adopt some kind of classification. This is true whether the information is accounting or statistical. The process to be followed can be well illustrated by citing the method employed by the Department of State Highways for its Maintenance Division repairs; 68-grader repairs; 80-depreciation. In order to identify which employe performed the labor and used the material, it was necessary to give each employe a permanent number so long as he remained in the department. Likewise, to ascertain from whom goods were purchased, each manufacturer or merchant is given a number known as an "account number." The same is true of certain large machines, as a cater-

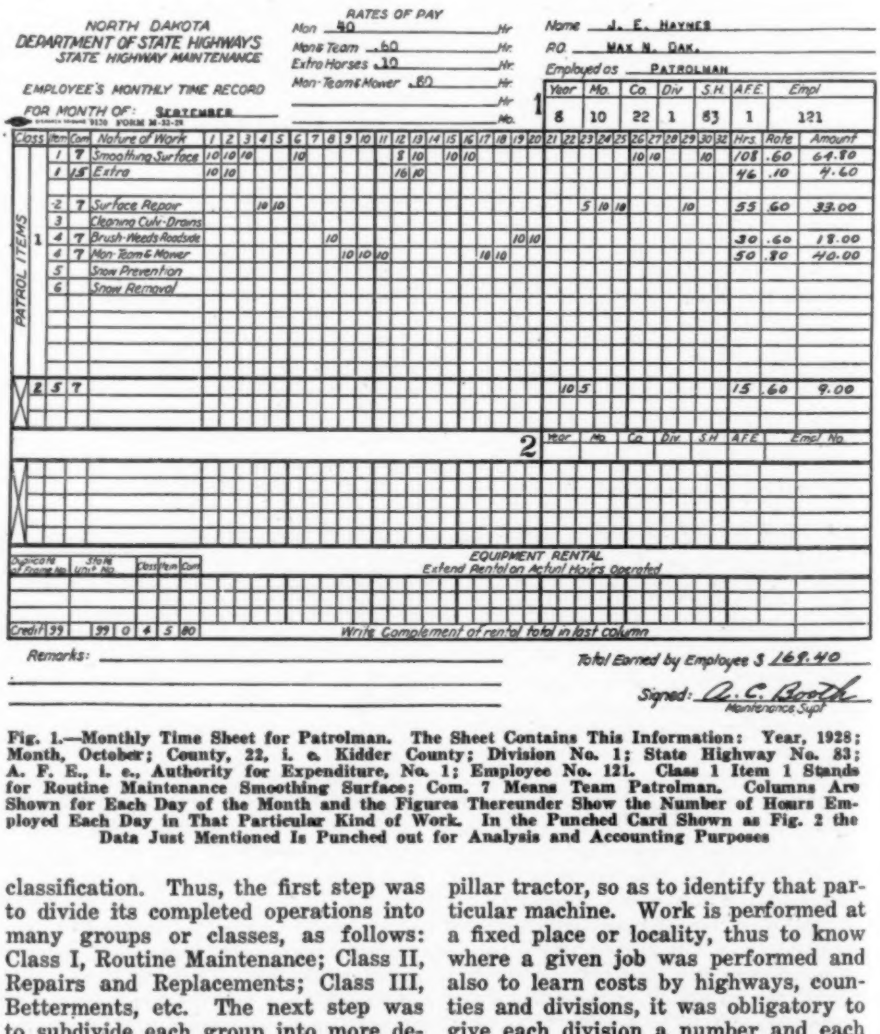


Fig. 1.—Monthly Time Sheet for Patrolman. The Sheet Contains This Information: Year, 1928; Month, October; County, 22, i. e. Kidder County; Division No. 1; State Highway No. 83; A. F. E., i. e., Authority for Expenditure, No. 1; Employee No. 121. Class 1 Item 1 Stands for Routine Maintenance Smoothing Surface; Com. 7 Means Team Patrolman. Columns Are Shown for Each Day of the Month and the Figures Thereunder Show the Number of Hours Employed Each Day in That Particular Kind of Work. In the Punched Card Shown as Fig. 2 the Data Just Mentioned Is Punched out for Analysis and Accounting Purposes

classification. Thus, the first step was to divide its completed operations into many groups or classes, as follows: Class I, Routine Maintenance; Class II, Repairs and Replacements; Class III, Betterments, etc. The next step was to subdivide each group into more detailed operations, which for Class I were: Item 1, Smoothing Surface; Item 2, Surface Repair; Item 3, Cleaning Culverts, etc. In the performance of any work, men, materials and machines are required. Hence, a labor and commodity group must be devised, which in the Maintenance Division, choosing some of them at random, were: 7-team patrolman; 15-extra horses; 25-gravel; 30-lumber; 38-sign markers; 62-truck pillar tractor, so as to identify that particular machine. Work is performed at a fixed place or locality, thus to know where a given job was performed and also to learn costs by highways, counties and divisions, it was obligatory to give each division a number and each county a number, as highways already were numbered. The number assigned to each patrolman as an employe identifies each particular patrol section. Detours, when used temporarily, are also specially numbered. Consequently, as every act, kind of material, employe, seller and locality is numbered, it is easy to use these numbers as a means of identification.

Application of the Code to Various

Kinds of Reports, Invoices, Etc.—Fig. 1 is a monthly time sheet of a patrolman. One can readily observe in the upper right hand corner his name and address together with the year, month, division, county and highway upon which he worked. The invoice of a seller or any other original report or document is coded in a similar way. This original data is not different in any respect from the ordinary business forms of any mercantile and manufacturing establishment.

The foundation for an analysis by the Hollerith tabulating devices is a specially designed pasteboard or card, 3¼x7⅜ in. in size and of specially prepared paper of material resisting somewhat the influence of electric current. Usually these cards carry 45 vertical columns of figures running from 0 to 9. Having designed the accounting or statistical code, the main captions or headings thereof must be transferred to the card. This is done by splitting or cutting the 45 columns into fields or sections. Fig. 2 presents the card used by the Department of State Highways for its Maintenance Division. Thus, from left to right we have columns for the year, the month, the day of the month and so on across the entire width. The black vertical lines are to aid the operator in locating the numbers which are to be punched out. Identical cards are used by all persons and firms, and the only difference in most consists in the difference in the field or sections employed and the captions or headings, that is, in the arrangement and location of the information sought. The department will have a number of these cards, depending upon what financial or statistical data it is desired to compile. To aid in a quicker segregation of major division information, colored cards are employed and readily disclose their nature at a glance.

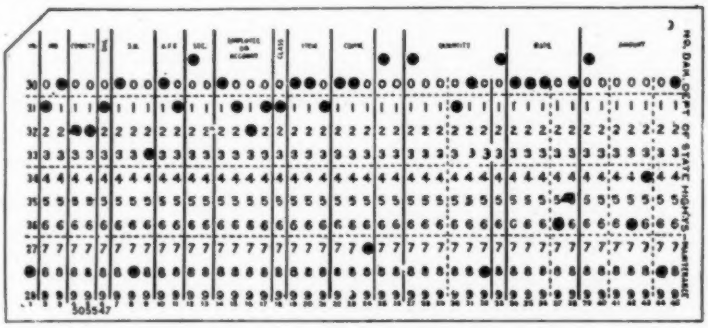


Fig. 2.—A Punched Tabulating Card

The Electric Key Punch.—This card is punched full of holes, thus transferring by means of the code, the information found on the time sheet, or other original document, to the tabulating cards. The electric key punch is the unit of the Hollerith machine tabulating and accounting method. Its operation is more simple than that of a typewriter and proficiency in its use is quickly acquired. In fact, any operator after a little experience and a fair knowledge of the code should punch between 300 and 400 cards per hour. With only fourteen keys, compactly arranged and requiring but a very light operating touch, the data is transcribed to the cards with the utmost ease and rapidity. The department also operates an electric duplicating key punch which records data on cards in the same manner as the preceding machine, but it is so designed that all information common to more than one card is recorded automatically. Any card in its entirety, or any portion of it, can be duplicated with absolute accuracy and with great rapidity. The unpunched cards are held in a magazine from which the individual cards to be punched are automatically fed into the punching position.

Sorting the Cards.—The sorting machine assembles all cards for each class of information and simultaneously arranges the various classes in numerical sequence. Cards can be sorted at the rate of 350 to 400 cards per minute and is readily accomplished by setting certain pointers at the column to which it is desired to sort. Thus, information can be sorted to year, month, county, highways or any minute information wanted. A demonstration employed at the department is to mark a card, punch it differently from 200 others, and then have the machine throw it on the first run. Again, by punching a number of cards alike according to their color, the machine assorts the cards to color much to the amazement of the spectator until let in on the secret.

The sorting is done electrically by electro-magnets. After the cards have been sorted down to the exact information sought and at the same time arranged in proper sequence, the second step is completed, but the information is not available in readily understandable form. Cards can be analyzed and re-analyzed as often as desired until they wear out from use. The data must now be counted or compiled.

How the Tabulator Works.—The most complicated machine of the Hollerith group is the tabulator. It is a machine that counts the cards, the amounts thereon, and prints the amounts and the totals. The department has the latest model of this type. When group totals are desired the electric accounting machine adds from one to five columns of figures simultaneously at the rate of 150 cards per minute; when detailed analyses are required this machine can be transformed instantly into a listing machine capable of printing from one to seven itemized columns of figures, together with group totals at the rate of 75 cards per minute. Ruled report forms can readily be inserted in the machine and finished reports secured in printed detail directly from the punched cards. The printing is done on a 20 in. carriage with single or double typewriter spacing. It accumulates grand totals in addition to the individual group totals. Carbon copies can also be made as well as the original.

Under the shelf on the tabulator is what looks like a telephone switchboard and is arranged somewhat to resemble the form of the punching card. By plugging various holes with the plugs, the machine will count, total and print the information from the cards previously sorted in accordance with the requirements sought. With each different analysis the machine must be rewired or re-plugged to count and tabulate the data. When once set, the machine works automatically after pushing a button.

How Machines Will Be Used.—The machines cost between $8,000 and $10,000 to build and must be "serviced" repeatedly to insure their complete accuracy for naturally such complicated machinery can easily get out of order unless operated with the utmost care. They cannot be purchased and so must be leased at a monthly rental.

Reports are either financial or statistical. The department of state highways will furnish both. At present, the reports issued by the maintenance division show the monthly expenditures for each class of work such as routine maintenance and for each item as smoothing surface and the total expended from the beginning of the year. Thus, one can learn how much was paid for road marking, machine operation, snow removal, etc. The report not only gives the figures for the entire state, but also for each of the six divisions and the central office. A similar report is issued showing how much was expended for labor, the kind of labor, such as patrolman, extra man, unskilled labor, for materials purchased as lumber, paint, road markers, etc., and also all kinds of machine operations and machine repairs. A third report sets out from whom goods are purchased and the amount bought from each firm. An illuminating report is one that shows the cost of keeping in good condition each patrol section of the State Highway System and so will permit a comparison of one patrolman's efficiency with that of another; a second will permit the comparison of the cost of maintaining entire highways as for

instance, a comparison of U. S. Road No. 2 with U. S. Road No. 10 for their entire length across the state; while a third report will show the cost of maintaining all the highways in each county. These costs will not only be kept in the aggregate but also upon an average cost per mile to afford a better comparison.

As soon as the installation of the revised accounts for the divisions of construction, bridges and others can be completed somewhat similar data will be compiled for them. In fact, the machines will do most of the accounting work. As the new law requires an account to be kept with each individual of the department, it will be easy to learn how much was paid him as salary, how much for travel expense and for what items such as board, hotel expense and car mileage as well as the number of miles traveled.

New Leaning Wheel Grader Developments

The Galion Iron Works & Mfg. Co. has announced two new Leaning Wheel E-Z Lift Graders, Nos. 77 and 78, and important improvements in their large size Nos. 10 and 12 E-Z Lift Leaning Wheel Graders.

The two new graders are smaller, lighter machines, of sizes for 7-ft. and 8-ft. mouldboards. They have all of the good features of the larger machines, including the Simplex pivotal frame adjustment and E-Z Lift gearing. Open E-Z Ligt springs are used however, instead of the enclosed springs operating under compression as used in the larger sizes.

Some changes have been made in the E-Z steer assembly for this size grader although the self-locking machine-cut worm gearing operating in oil in an oil-tight gear case is used. The operation of this steering device is said to be very easy and positive. In the large Galion Leaning Wheel Graders with 10 and 12-ft. mouldboards all of the good features have been retained and in fact the changes are more in the appearance than in the operating features.

The big enclosed lift springs operate as powerfully as ever in helping to lift the mouldboard, but they have been placed down out of sight between the frame members, according to the manufacturers. Some slight changes have been made in the placing of operating levers and cranks and minor developments have been made in the steering asembly.

Perhaps the most important change of all is in the "bottom," as blade and circle are called. The former cast steel full circle proved strong and satisfactory, but the new semi-circle is said to be equally strong and its use has permitted a reduction in weight which makes handling easier than ever.

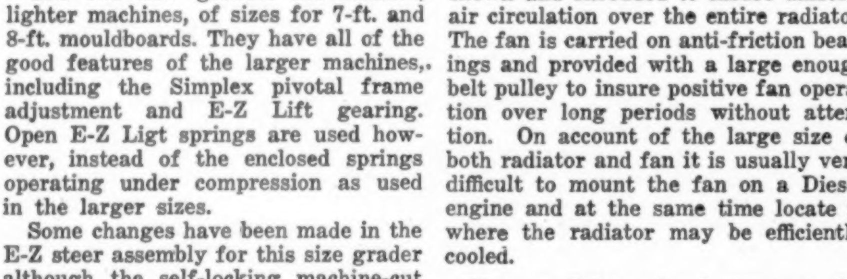
This semi-circle, and in fact, all semicircles on Galion Leaning Wheel Graders are now made of railroad rail of ample strength and weight, formed hot on the big Galion bull-dozers. Railway rail makes a very stiff and strong semi-circle and these new type semicircles on Galion graders will meet requirement of service, the manufacturers claim.

New Type Perfex Radiator for Diesels

A new type of radiator for Diesel and heavy duty engines has just been announced by the Perfex Corporation. The new feature is the mounting of an unusually large air circulating fan directly on the radiator frame. This is completely protected by a screen as shown and shrouded to insure uniform air circulation over the entire radiator. The fan is carried on anti-friction bearings and provided with a large enough belt pulley to insure positive fan operation over long periods without attention. On account of the large size of both radiator and fan it is usually very difficult to mount the fan on a Diesel engine and at the same time locate it where the radiator may be efficiently cooled.

These radiators also incorporate the latest developments in removable core sections. Each unit is securely held in place by four nuts. This permits removal and repair of any individual section without dismantling the radiator and also continued operation of the power plant for reasonable periods while a section is out. An alternative is to carry a reserve section which can be put in the place of a damaged section in a few minutes.

The cores of these heavy duty radiators are made from copper to prevent corrosion. The tubes are oval in shape, have double lock seams that make them burstproof when frozen.



The Improved Models of Galion E-Z Lift Graders are Typified by the Model Shown Here

Causes of Highway Accidents

An intensive highway safety campaign designed to cut down highway accidents which exacted a toll of 141,497 lives during the six years previous to 1928, will be planned during the annual meeting of the American Road Builders' Association which convenes in Washington, D. C., on May 11. A meeting of the County Highway Officials' Division will be held the following day.

It is pointed out by the association that the accidents are the result of the failure of the human machine rather than errors of engineering or mechanics. The major cause of highway accidents and the estimated number resulting from each during 1927 were listed.

Inattention was the major factor in the killing of 4,584 persons during 1927, according to estimates of the association. Children crossing or playing in the streets in violation of traffic rules was the second greatest contributor, causing the death of an estimated 3,638 children. Adult jay-walking took a toll of 3,069 lives. The total number of persons killed is estimated at 26,618, and the number of injured at 798,700. During the past six years approximately 3,446,000 persons have been seriously injured in these accidents, and an economic loss suffered estimated to total $3,572,791,000.

Highway accident fatalities caused principally by motorists during 1927 were estimated at 11,765. The causes were as follows:

	Per Cent	Total
Inattention	32	3,765
Speeding	23	2,706
Traffic Violation	20	2,353
Intoxication	9	1,059
Miscellaneous	16	1,882

Fatalities caused principally by pedestrians were estimated by the American Road Builders' Association to total 11,367. The causes were as follows:

	Per Cent	Total
Children playing in the street or crossing in violation of traffic regulations	32	3,638
Adult Jay-Walking	27	3,069
Inattention	16	1,810
Confusion	14	1,591
Other causes	11	1,250

Fatalities caused principally by physical conditions were estimated by the association to total 3,486, with causes as follows:

	Per Cent	Total
Fog, snow or rain	37	1,290
Defect in vehicle	19	662
Skidding	16	558
Road defect	11	383
Strong lights	7	244
Poor street light	7	244
Confusion in dimming lights	3	105

The May meeting of the American Road Builders' Association will be partially concerned with the solution of the highway accident problem. It is expected that the officials of the organization will approve a plan to conduct an intensive highway safety campaign, using the principles of courtesy and caution as the basis for the movement. In the opinion of the association officials, courtesy and caution are the two main factors in bringing about safety on the public thoroughfare.

Paving Mile Unit of County Highway Connecting Two Main State Highways

An Example of Current Methods Used on Secondary Roads in Cook County, Ill.

TWO of the main highways leading out of Chicago carrying a heavy traffic are, like other state highways in the district, being interconnected by secondary highways that will serve to divert traffic from the more congested highway to the nearest that may not be carrying as heavy a traffic, and that will act as feeder highways for the main routes, thus making these main routes accessible from intervening residential areas that are under development. A typical case of this kind is the highway known as 25th Avenue, running through the village of Belwood, Ill., just west of Chicago. This road intercepts, from north to south, Lawrence Ave., Irving Park Blvd., Grand Ave., North Ave., Lake Street, St. Charles Road, Washington Blvd., Madison St., and Roosevelt Road, most of which are continued beyond this feeder road but two of which are dead ended at this road at present. Part of this route, which thus intercepts a number of important east and west highways, has already been paved. This season one of the unpaved sections of this important feeder highway was paved by the county. This section, approximately 1 mile in length, extends from Roosevelt Road north to the Chicago, Aurora & Elgin Railway right-of-way and connects with a section paved one or two years previously. These two recently completed sections thus take the dead ended Madison St. and Washington Blvd. traffic and divert it to either Roosevelt Road or St. Charles and Butterfield Roads in accordance with the wishes of those using these routes.

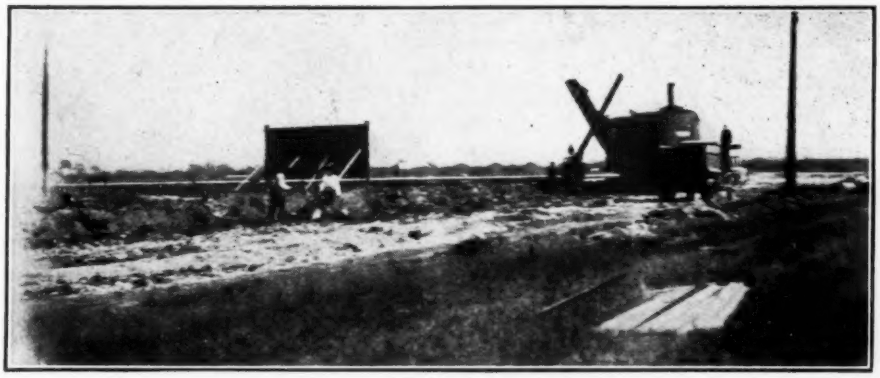


Fig. 1.—The End of the Rough Grading, with Only One of the Shovels Still on the Job

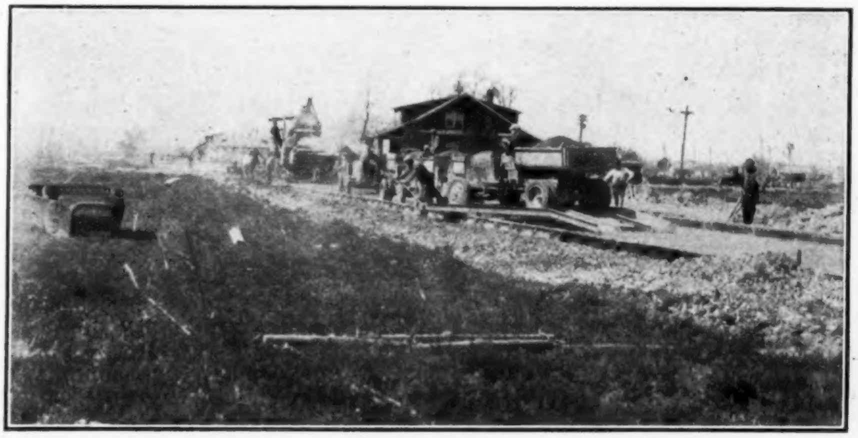


Fig. 2.—Batch Trucks Being Swung Around by the Turntables on Their Way to the Paver

Fig. 3.—The Paver and Finisher in Operation, with the Stockpiles in the Background

Design.—The new pavement, which is of concrete, conforms to state design and specifications and was supervised and paid for by the county. The section has a thickened edge, 9 in. in thicknesses for a width of 1 ft., and thinning out to 7 in. in a further width of 2 ft., which thickness is maintained to the center line. A steel center joint separates the slab into two strips. The pavement just laid is 20 ft. in width, and widened to 40 ft. at the intersections by the addition of two 10 ft. shoulders separated from the main slab by the same sort of a metal joint as is used on the center line. The intersections are paved to a wide radius, and dirt shoulders have been built up after paving.

Rough Grading.—Rough grading on this project was done with two power shovels each of ¾ yd. capacity, loading into motor trucks. The crew on each shovel included 1 operator, 1 fireman, and 4 pit men, the two outfits being in charge of 1 foreman. Spoil was partly used in grading up nearby residential property and partly for building up shoulders.

Final Grading.—Final grading was done with a Hug subgrader and an Austin Pup roller just ahead of the paver. The soil was well consolidated except for that part disturbed by the grading operations, since the right-of-way had been used as a dirt road for some years and had carried a fairly heavy traffic.

Stock Piles.—In order that the paver could be served efficiently, stock piles were built up as needed on adjoining paved streets, with the delivery trucks

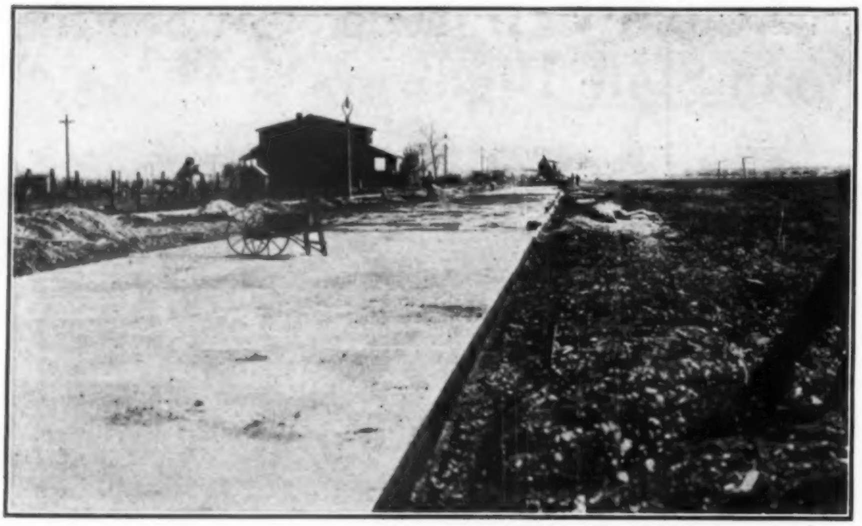


Fig. 4.—The Finished Pavement Was Covered with Wet Burlap Until the Morning After Laid and Then Uncovered and a Layer of Calcium Chloride Applied with the Device Shown

Fig. 5.—Trucks Brought Shoulder Material from the Grading Operation and the Shoulders Were First Shaped with a Fresno

Fig. 6.—The Blade Grader Outfit Shaping the Shoulders at a Wide Intersection, Completing the First Part of the Job.

dumping the sand and stone directly on the existing pavement. Cement was brought in on trailers and loaded directly from the trailers onto the batch trucks as needed. Batch trucks were loaded with aggregates from the stock piles by one Haiss loader for each material. The batches were hauled to the paver in a fleet of 7 International single batch dump trucks, which kept the paver well supplied. A turntable was used to permit the trucks to back up to the skip of the paver.

Mixing the Concrete.—The batch trucks brought the batches to a 27-E Multi-Foote paver in 6-bag 1:2:3½ batches, and water was added in the mixer to give a slump of 1 to 1½ in., this water content being constantly gauged by means of the standard slump test. Test beams were cast periodically to check up on the strength of the concrete going into the pavement.

Finishing.—As fast as deposited on the subgrade the concrete was finished with an Ord finisher, belt, and floats. As rapidly as finished, the slab was covered with wet burlap, which was allowed to remain in place until the next morning, when it was removed and the surface covered with calcium chloride at the rate of 2½ lb. per sq. ft.

Shoulder Work.—As soon as the concrete was adjusted strong enough to permit use by the shoulder crew the work of building up the shoulders was started. Here, the trucks receiving spoil from the grading operation at one end of the job would bring in loads to be dumped against the edge of the slab as shoulder material, and this dirt would then be built to approximate section by means of a 2-up 2-man fresno outfit. Further shaping was effected with a small blade grader pulled by a 2-up team.

Crew Required.—With the equipment already enumerated, and the following crew, the contractor was able to average 40 to 45 batches an hour and 700 lin. ft. of 20 ft. pavement per 8-hour day. The crew found on the job was as follows:

On each shovel—
- 1 Operator.
- 1 Fireman.
- 4 Pit men.

On grading—
- 1 Machine operator.
- 4 Form setters.

On stockpiles—
- 6 Cement hands.
- 2 Loader operators.
- 1 Helper.
- 7 Truck drivers.

At paver—
- 1 Paver operator.
- 1 Finishing machine operator.
- 1 Turntable man.
- 1 Dumper.
- 4 Puddlers.
- 1 Water and steel laborer.
- 2 Finishers.
- 1 On burlap and chloride.

On shoulders—
- 2 Skinners.
- 1 Grader operator.
- 1 Fresno hand.

Those in Charge.—The work was done for the Cook County Highway Department by Stanly Jaques, contractor. The county was represented by R. J. Rich, County Engineer, W. E. Bates, Construction Engineer, and A. Doff, Inspector. The contractor was represented by Mr. Jaques himself and by Rudolf Waltjer, foreman.

Southwest Road Show.—The fourth annual Southwest Road Show and School will be held at Wichita, Kan., Feb. 26, 27, 28 and March 1, 1929.

Desirable and Reasonable Traffic Regulations For General Use

An Outline of the Details of General Traffic Control

By E. W. JAMES
Chief Divison of Design, U. S. Bureau of Public Roads, Washington, D. C.

IN the course of the last ten years the civil engineer who has made highway work his specialty has found that a new phase of highway activity has been rapidly growing in importance. We were formerly concerned with highway construction and maintenance; we are now concerned with highway construction, maintenance and operation, and by no means the least of these activities is highway operation. While highway transport is acquiring more and more the characteristics of railroad transport in many of its aspects, highway transport is characterized by, and must be protected in, retaining the element of flexibility which makes it of such outstanding importance. We have a relatively high-powered vehicle which does not operate on individual trackage. We place at the throttle of this vehicle any person with ordinary intelligence. The manufacturer is constantly striving to widen his market, and cheapen the equipment to a point where it will be available to smaller and smaller incomes and a constantly extending use.

The automobile is rapidly becoming an expression of American life. Freedom of movement, like freedom of speech, freedom of the press and freedom of worship are fundamentals of American liberty, and the outstanding instrumentality of freedom of movement in America today is the individual automobile and the commercial truck. Thirty years ago, when our automobile registration was 4,600, we were figuratively still sitting at the feet of the French road builder, taking lessons in the testing of materials, the drafting of specifications and methods of construction, and no state in the Union had an improved highway entirely across it in any direction. Since then we have become the foremost road-building nation of the world, and our progress in the science and art of highway construction has been so great that today all the world is turning to the United States for ideas and guidance in the expansion of their own older highway systems. The automobile industry has grown until it has produced in excess of 4,000,000 vehicles in a single year, to accommodate which on a 15-ft. headway would require over 21,000 miles of highway. To construct, maintain and operate highways under such pressure is a matter of the greatest national urgency. With respect to the operation, with which we are particularly concerned, our problem is twofold,—to make adequate provision for what we have in the way of transport, and to take preventive measures against a national jamb in the future.

If funds are forthcoming, the highway engineer can take care of construction and maintenance. The highway-building industry is today equipped to take care of any probable emergency in this direction. The serious problem lies in the field of operation. As conditions exist it is more dangerous today to drive a car than it is to have typhoid or diphtheria or both, and to drive a car for ten years is more dangerous than to be called upon once in ten years to serve in an expeditionary force in a great foreign war. In the last ten years we have lost by death in automobile accidents about 30,000 more than the entire losses in battle, by disease, suicide or accident during the period the United States was engaged in the World War.

The railroads have found it necessary to establish elaborate and exact operating regulations. Railroad engine drivers are highly skilled men of mature years, physical soundness and having good judgment. Our great problem is to establish an equally efficient set of operating rules, applying them to the drivers of automobiles and trucks, and do this in a manner which will not destroy the outstanding advantage of motor transport which is its great flexibility.

I submit to you two fundamental principles which I think must apply in such an effort; these are the rule of uniformity and the rule of reason.

Rule of Uniformity.—I believe the first rule is generally accepted. We have had the Hoover conference on street and highway safety prompted solely by an effort to induce unified action by the several States in all matters pertaining to highway traffic, including traffic regulations. Out of this conference has grown the Committee on Municipal Traffic Regulations, which is now actively engaged in formulating the details for the regulation of traffic in municipalities. The Association of State Highway Officials has undertaken to promulgate a uniformity of highway marking, including a variety of caution and danger signs. As all of this work has progressed it was found that there existed so great a variety of regulations, rules on the road, and methods of conveying instructions as to amount almost to a chaotic condition. In the three and a half years since the meeting of the first conference on street and highway safety there has been a decided change for the better, but much remains to be done. The immediate accomplishment has been the general acceptance of the rule of uniformity. When a man can drive in any city or in any State with the same confident familiarity with driving requirements that he possesses with respect to his own community, I believe much will have been done to reduce the needless stream of accidents that now flows along with our highway traffic. In admitting that the application of this fundamental rule is difficult and will be slow, I speak from a full and wide experience, but past performance is encouraging, and I believe that we may look for the relinquishment of pet ideas, of the desire to be different, and of the tendency to enforce unique restrictions, and for the ultimate adoption of regulations which may be everywhere communicated in approximately the same form and enforced in essentially the same way.

Rule of Reason.—The rule of reason does not yet occupy so sound a place in our public handling of traffic problems. This always characterizes the rule of reason when applied to any activity. Devising a test of reasonableness is the very first difficulty. Shall we, for instance, base our test of reasonableness on speed or on congestion? In order to avoid the latter, shall we throw down the bars to speed? In order to avoid speed shall we aggravate congestion?

In the last three or four years there has been a pronounced tendency in State traffic laws and local regulations to permit, or even encourage, high speeds. On the other hand, some investigators have shown that a traffic lane will deliver per hour more vehicles operating under safe conditions and at a speed of 15 miles an hour than at any higher speed. In some cases the whole question is dodged by an effort to control reckless driving only, whether this is required in speed or in handling the car. I am of the opinion that a substantial per cent of our accidents today are the result of overspeeding with respect to the conditions existing. We can imagine congestion, but it is diffi-

cult to imagine a serious automobile accident if all cars were operating at six miles an hour. The fact that 63 per cent of the accidents in Connecticut occur on good road surfaces, that 59 per cent occur in daylight, that 78 per cent occur in clear weather, that 38 per cent occur on a clear course, and the further significant fact that the rate per one thousand accidents for drivers under twenty years of age is three times that of drivers over thirty and four times that of drivers over fifty confirms me in this opinion. This is further supported by the fact that the driver is considered to blame in 74 per cent of all cases.

The adjustment to be made in determining the rule of reason as applying to speed and congestion is to fix after adequate study what will reduce congestion to the lowest amount obtainable with the greatest safety. If this results in relative congestion on our streets and highways, then the remedy is other routes or wider routes. This is the sound way to take care of all conditions which exist, and indicates the preventive measures for the future to which I have already referred.

Results of Surveys at Cleveland.—Recent surveys have been made in the vicinity of Cleveland, O., and in the city, where there exists on different routes a great variety of traffic, and where there is at some points an excessive and annoying congestion. A space-time recording apparatus was used for determining changes in speed and distances covered. A careful census of total traffic was made on all the routes studied. In operating the test car, carrying the space-time recorder, the experiment required that the operator put the car into the stream of traffic and keep it there as nearly as possible in coincidence with the general flow of vehicles. If one car passed him, he was instructed to pass one car, thus retaining his relative position in the line of traffic, but he was not to weave about with the purpose of gaining advantage in position so that he might increase his speed. He deliberately operated with the general flow of traffic. A recorder kept notes of events during the run, and the figures which I have to submit are those which were produced where conditions of congestion were just avoided. It was found that where the traffic on a 2-lane road was at the rate of 3,000 per day (twenty-four hours) an average speed of 36 miles was possible. With 4,000 traffic per day a speed of 34 miles was attained; with 7,250 a speed of 25 miles was recorded. On a road which was unnecessarily wide for two lanes, but hardly qualified as a 3-lane road because of parking conditions, a daily traffic of 8,500 vehicles permitted a speed of 28 miles, and a daily traffic of 12,250 a speed of 24 miles. If this is considered a 3-lane road it will be seen that these values fit in exactly with the previous figures for a 2-lane road on the basis of traffic per lane. On a 4-lane route the the following conditions were observed: When 12,000 vehicles per day were passing, a speed of 29 miles was possible; with 17,000 vehicles the necessary speed dropped to 28 miles; with 29,000 vehicles the speed was 24 miles an hour; and with 32,000 the speed was 23½ miles per hour.

Studies were made on other routes with somewhat greater refinement with respect to the traffic census. On a certain 6-lane road with 1,300 vehicles per hour a speed of 16 miles was attained; with a traffic of 1,700 per hour a speed of 14 miles was indicated by the tests. A similar more refined study on a 4-lane route covering 1,300 per hour indicated a speed of 16 miles per hour, and one covering 1,500 per hour the speed was forced down to 9 miles. These studies, while indicating higher speeds for the most part than those resulting from a mathematical study such as that made by Dean A. N. Johnson, clearly show, nevertheless, that a given traveled way will carry more vehicles at a lower speed under average conditions of operation.

The accidents reported in the city of Cleveland and shown on a spot map indicates that along the routes where the above figures have been secured the relative safety of driving is what may be referred to as normal or average. With the speeds and the traffic indicated the rate of accidents per 1,000 vehicles was neither substantially above nor below the rate on other thoroughfares.

This still leaves us in doubt as to whether a further restriction of speed would or would not reduce the accidents on these particular routes, but the studies are reasonably conclusive that the speeds were not so low as to be the cause of congestion, inasmuch as the capacity of the routes was continuously increased down to the lowest speed indicated. The result of these particular studies, therefore, would appear to indicate that speeds above 20 or 25 miles per hour are not necessary to reduce congestion. If carefully coincident studies could be made to determine whether accidents on these particular routes or other routes similarly studied are at a greater rate for higher speeds, it will probably be possible to fix upon a reasonable speed which will reduce accidents to a minimum and at the same time cause no congestion and maintain the capacity of the route at as high a point as can be conceded to the demands for saving time. Whether a similar speed limit should be fixed for the open highway is a question which should receive further careful study along similar lines, and in coming to a conclusion it should be borne in mind that one of the purposes of present regulations is to prevent future traffic difficulties. It is therefore better to maintain relatively low speeds not absolutely required by route capacity at this time in order to avoid the necessity of re-educating the public to low speeds in the future after they are thoroughly accustomed to high speeds.

Red and Yellow Lights.—There are several other matters which are still in the debatable zone when we apply our rule of reason, and conspicuous among them is the use of red and yellow lights. Red is almost universally recognized on the highway as a stop light. The Association of State Highway Officials, however, has adopted a stop sign with a yellow background, and the question of red or yellow for automobile tail lights is still unsettled. It occurs to me that there is a rather nice distinction that can be made with respect to the use of red or yellow which may be stated somewhat as follows: red signifies to stop and to remain stopped until the signal changes or some other instruction is given to proceed; yellow signifies caution, and if a yellow sign instructs traffic to stop, it indicates that extreme caution is necessary and that traffic should stop, but may then proceed past the stop sign without change of signal or other instruction when the driver is assured that he may safely proceed. This formula appears to come nearer fitting all of the conditions logically than any other I have heard. It permits the continued use of red tail lights, red lanterns on fixed obstructions, and yellow boulevard stop signs where the intersection is not automatically or otherwise controlled.

Where control lights are operated at an intersection the color cycle also varies. According to present practices it is "Red-Yellow-Green-Yellow" in some cases, and "Red-Green-Yellow" in others. The use of the yellow interval between the red and green is in question. The present trend of opinion, however, appears to be in favor of the "Red-Green-Yellow" cycle, and the reason for this appears sound. On the open street the yellow should flash, while the red still shows on the closed street; then when the yellow goes off the red goes on the formerly open street; the green should at the same instant come on the formerly closed street. This sequence gives warning on the open street that the red is about to flash, and provides opportunity for the intersection to be cleared before the green goes on the intersecting route.

Pavement Markings.—There is a growing tendency to use pavement markings, and a word should be said regarding more particularly the use of the continuous white line. It appears desirable that the continuous white line should be used only where it should never be crossed. This is a simple rule which the public can easily learn even if they disregard it in practice. Such a white line is the best possible witness in case of an accident. The man whose car is on the wrong side of such a line has no justification whatever. If such continuous lines are used where they may be crossed and where they may not be crossed confusion will always exist in the minds of drivers. Practice in

the use of the continuous white lines is gradually crystallizing for the following uses:

(a) Centerline on a curve having a radius of less than 600 ft.
(b) Centerline on a grade steeper than 6 per cent.
(c) Centerline on vertical curves where the clear sight distance is less than 500 ft.
(d) Traffic lanes on streets wide enough for three or more lanes, where direct approach to certain critical areas is necessary.
(e) Street-car landing areas.

Where white lines are considered necessary to indicate the boundary of pedestrian cross-walks, of vehicle turning limits at street intersections, at street-car clearance limits at turning points, or to indicate parking space, broken lines should be used.

Considerable difference of opinion still exists with respect to the time and method of making left and right turns at controlled intersections. Left turns are sometimes made on the outside of the intersection; sometimes closely around the center of the intersection. Right-hand turns are sometimes permitted and sometimes not permitted against the red light on the closed street. These two sets of conditions must be handled together.

In the first place, if we are to adhere to the significance of the red light, a right turn should not be made against it. If this is established, then the left turn at the center of the intersection will tend to obstruct traffic more or less seriously whenever vehicles waiting the right turn are standing close to the intersection. Therefore, if right turns against the red light are prohibited, left turns should be made on the outside of the intersection. This relation appears to be the soundest solution. It can be used on both wide and narrow streets where control is automatic or by police direction, and it throws all vehicles waiting both the left and the right turn over to the extreme right-hand side of the approaching street and intersection. Any other combination appears to have some greater disadvantages.

I have confined myself to those details of general traffic control which are at the present time most in dispute. Other details which are subject to a variety of adjustment are controlled by local situations existing. For instance, the one-way street has its supporters and its opponents, but after all it is a matter of the physical routing of traffic rather than a rule of the road. The parking question is a very serious one and widely and vigorously disputed, but it is a purely local question in every instance, and often it is local to individual streets or to blocks in a single street.

Such questions, however, are of the greatest significance in pointing the way toward those preventive measures which must be seriously considered if we are to meet future conditions which now appear probable. These preventive measures have very wide ramifications. They involve not only the question of routing and of parking space, but the details of highway and street design, and ultimately of city and regional planning. In all of these directions some work is being done, but we are not yet ready to draw definite conclusions with respect to many of the details. Highway engineers are perhaps more nearly in agreement on details of design to accommodate traffic than traffic directors are with respect to one-way streets or the parking privilege. And those devoted to city and regional planning are carefully studying the questions of building height and capacity, street layouts, decentralization, and the segregation and grouping of various business activities. All of these matters are involved in preventive measures for the future, which will make possible the continuation of urban growth and development without burdening such communities with exorbitant expenditures to overcome chaotic and impossible traffic conditions.

Specifically, at this time we are in need of information regarding the traffic density on 2, 3 or 4 lane intersections when automatic signals should be introduced, and the further point in traffic density when police control should be adopted. There are still to be found many who believe that traffic moves more rapidly and even more safely when it is permitted to make its own way through intersections. Undoubtedly traffic control has been installed where not needed. This is because we do not know for any given case what the critical points of capacity are. This should be studied.

Further studies should be made regarding the increased efficiency of a highway due to the introduction of rotary intersections or grade-crossing separations. Theoretically a grade-crossing separation should give us an increased efficiency of at least 50 per cent. It is probably more than that. Such a large saving may warrant the expenditure of much greater sums for this kind of work than we have believed justifiable heretofore.

Studies regarding the detailed design of rotary intersections are imperatively necessary at once. The Bureau of Public Roads is now considering a rather wide study of this last matter, and it may be expected that within a reasonable time some data much more valuable than any now available will be in hand.

The use of this material is going to be necessary in the near future, for it requires but little imagination to picture the impossible condition which will result if we depend entirely on methods of immediate control for the solution of all possible traffic problems, and reject those preventive measures which promise so great an advantage for the future.

Acknowledgment.—The foregoing is a paper presented April 18 before the Affiliated Technical Societies of Boston.

Parking and Traffic

As a method of approaching the ubiquitous parking problem, the Civic Development Department of the Chamber of Commerce of the United States recommends certain steps in a report just issued on "Automobile Parking in Business Districts."

Pointing out that the parking problems is not the same in all cities, the Department makes six recommendations:

"1. Make a traffic survey. Such a survey should include not only a count of vehicles, but also a count of customers. In this count of customers the usual questions about the vehicles they used in getting down-town should be preceded by the question: Did you come down-town to shop or did you come for some other reason with shopping merely incidental?

"2. Determine what are the most important traffic needs of your central business district (or of your outlying business districts) and list them as nearly as you can in order of importance.

"3. See whether less important traffic is interfering with more important traffic and, if so, whether it cannot be diverted from the district or confined to out-of-business hours.

"4. Secure the adoption of a traffic ordinance. Don't adopt all the regulation you can think of, but only those which are necessary.

"5. Study the effect of building of varying bulk and use upon street traffic as a guide in influencing future building.

"6. If you have no city plan or zoning regulations, consider their value as means of securing permanent improvement in traffic conditions."

Cost of Street Cleaning at Washington, D. C.

The following table from the report of the operations of the engineer department of the District of Columbia shows the unit cost of street cleaning for the fiscal year July 1, 1926, to June 30, 1927:

	Area, square yards	Cost per 1,000 sq. yd.
Horse sweepers	70,848,000	$0.319
Hand sweepers	60,126,000	.176
Alley cleaning	108,250,000	.571
Suburban cleaning	57,831,000	.447
Hand patrol	1,739,011,000	.122
Motor flushing	705,056,000	.0714

Mortar Beam Tests

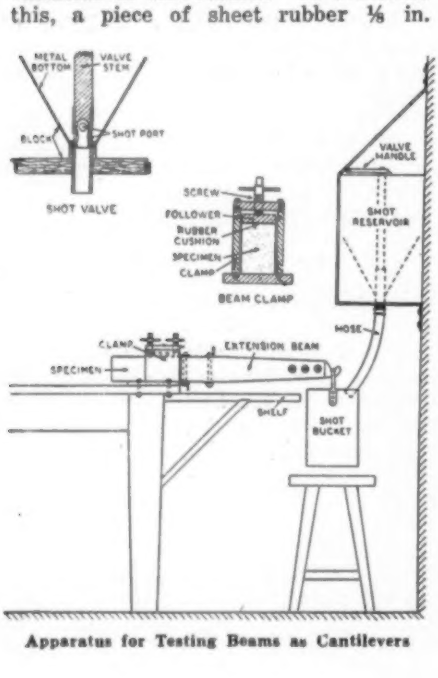
Cantilever Testing Apparatus Described in May Public Roads

By D. O. WOOLF
Junior Materials Engineer, Division of Tests, U. S. Bureau of Public Roads

THE Division of Tests of the Bureau of Public Roads has recently designed an apparatus for testing cement mortar beams under cantilever loading which is similar in a general way to that developed by the Illinois Department of Public Works for tests of concrete and described by H. F. Clemmer in the May, 1926, issue of Public Roads. The apparatus was designed to furnish a more rapid method of testing mortar beams in flexure and which could be employed in laboratories not equipped with a universal testing machine of sufficient sensitivity to test such beams.

The apparatus consists of a clamping device to hold the beam securely and an extension arm which fastens on the end of the beam and transmits the load as shown in Fig. 1. The beam may be loaded by any means that is at hand. In the bureau laboratory, No. 12 lead drop shot are used to apply the load. The shot are fed from a reservoir fastened to the wall, and equipped with a quick-action valve which opens completely by moving the control handle through a 60° arc.

The two thumbscrews shown in the clamping device bear on a steel plate ⅜ in. thick, which rests on the specimen. The beam is tested in the same position that it is molded, i. e., with the troweled surface up. Slight irregularities in the troweled surface have prevented an even distribution of stress over the surface exposed to restraint, and have consequently given poor breaks with an accompanying wide variation in test results. To overcome this, a piece of sheet rubber ⅛ in. thick is placed between the bearing plate and the specimen. This has given very good results.



Apparatus for Testing Beams as Cantilevers

The test specimens, 2 by 3 by 12 in. beams, are made in steel molds. The use of such molds, with carefully machined surfaces, is considered highly advisable.

Computations of the modulus of rupture are made using the formula

$$S=\frac{Mc}{I}$$

where
S=modulus of rupture, in lb. per sq. in.,
M=bending moment in in.-lb.,$=W_1l_1+W_2l_2$
where
W_1=test load, in lb.
l_1=distance of load from support=18.12 in.,
W_2=weight of arm,
l_2=distance of center of gravity of arm from support,
c=distance of extreme fiber from neutral axis, or 1½ in.,
I=moment of inertia of cross section of beam about its central horizontal axis.

Substituting the particular constants which applied for these tests, and neglecting the weight of the overhanging beam we have,

$$S=12.4+6.04W, \text{ (lb. per sq. in.)}$$

Neglecting the weight of the overhanging section of the beam is in accordance with the usual practice in testing beams for flexure under center loading.

To demonstrate the suitability of this apparatus for testing beams, four series of beams were prepared for comparative tests in the cantilever apparatus and in a universal testing machine under center loading. Each series included five or six 18-in. beams for test under center loading, and an equal number of 12-in. beams for test in the cantilever apparatus. Series B, C, and D were made of a 1:3 mix and series A of a 1:2 mix using Potomac River sand in all series. Series A was tested at an age of 14 days, series B at 28 days, and series C and D at 7 days.

The various series were made in the laboratory as time permitted. Because of the small number of molds available, no effort was made to tie the four series together. In series A, each specimen was made from a separate batch, the 18-in. beams being made first. Inspection of the test results of this series indicates that the water-cement ratio may not have been exactly constant for the two sizes of beams. When tested as cantilevers, the halves of the original 18-in. beams check the center loading tests, whereas the 12-in. beams tested as cantilevers show somewhat lower values. To guard against this, and to furnish a better comparison between the two methods of testing, in series B, C, and D each 18-in. and the corresponding 12-in. beam were molded simultaneously from the same batch.

The 18-in. beams were tested in an Olsen universal testing machine of 40,000 lb. capacity. A small beam rider was used which decreased the machine ratio by 10, and permitted accurate reading of the applied load to the pound. A span of 15 in. was used and the beams were mounted on rockers in accordance with approved practice. The rate of application of the load was such that the modulus of rupture developed at an average rate of about 100 lb. per sq. in. per minute. The broken halves were then tested in the cantilever apparatus to serve as a check. These last tests are shown in Tables 3 and 4.

The 12-in. beams were tested in the cantilever apparatus, applying the load at a rate of 15 lb. per minute. This produced a stress increasing at the rate of 102 lb. per sq. in. per minute. Two breaks were made on each beam. The beam was inserted in the clamping device and the extension arm hung on the free end of the beam. The beam was then so adjusted that the base of the extension arm was 1/16 in. from the clamping device. This space is the minimum sufficient to permit flexure without binding. The beam was then firmly fastened and loaded to failure.

TABLE 1.—*Results of tests under center loading in universal machine using 15-inch span*

Series A, mix 1:2, age 14 days		Series B, mix 1:3, age 28 days		Series C, mix 1:3, age 7 days		Series D, mix 1:3, age 7 days	
Breaking load	Modulus of rupture	Breaking load	Modulus of rupture	Breaking load	Modulus of rupture	Breaking load	Modulus of rupture
Pounds	*Lbs. per sq. in.*	*Pounds*	*Lbs. per sq. in.*	*Pounds*	*Lbs. per sq. in.*	*Pounds*	*Lbs. per sq. in.*
487	608	415	510	320	400	308	385
435	544	420	525	316	395	363	454
416	520	420	525	315	394	345	431
396	495	379	474	320	400	332	415
438	547			383	478	318	398
Average... 543		Average.... 511		Average.... 413		Average.... 417	

TABLE 2.—*Results of tests of 12-inch beams in cantilever apparatus*

Series A, mix 1:2, age 14 days		Series B, mix 1:3, age 28 days		Series C, mix 1:3, age 7 days		Series D, mix 1:3, age 7 days	
Breaking load	Modulus of rupture	Breaking load	Modulus of rupture	Breaking load	Modulus of rupture	Breaking load	Modulus of rupture
Pounds	*Lbs. per sq. in.*	*Pounds*	*Lbs. per sq. in.*	*Pounds*	*Lbs. per sq. in.*	*Pounds*	*Lbs. per sq. in.*
85.0	526	86.3	533	69.5	432	72.0	447
82.0	508	84.5	523	74.0	459	69.5	432
86.5	535	76.7	475	63.5	396	67.0	417
88.5	547	84.0	519	63.5	396	68.5	426
77.5	481	85.0	525	63.5	396	66.0	411
85.0	526	81.3	503	59.2	370	73.2	455
79.0	490	79.0	490	66.0	411	61.0	381
87.0	538	81.3	503	68.5	426	58.5	366
78.5	487	77.5	480	64.5	402	76.0	472
73.0	454			64.0	399	64.0	399
90.0	556						
82.0	508						
Average... 516		Average.... 506		Average.... 409		Average.... 421	

TABLE 3.—*Results of tests of 9-inch beams in cantilever apparatus*

Series A, mix 1:2, age 14 days		Series B, mix 1:3, age 28 days		Series C, mix 1:3, age 7 days		Series D, mix 1:3, age 7 days	
Breaking load	Modulus of rupture	Breaking load	Modulus of rupture	Breaking load	Modulus of rupture	Breaking load	Modulus of rupture
Pounds	*Lbs. per sq. in.*	*Pounds*	*Lbs. per sq. in.*	*Pounds*	*Lbs. per sq. in.*	*Pounds*	*Lbs. per sq. in.*
84.0	518	82.0	507	62.5	390	63.0	393
87.0	538	88.3	545	62.5	390	72.0	447
87.5	541	83.3	515	74.0	459	71.0	441
91.0	562	71.3	442	65.0	405	70.0	435
88.5	547	87.3	539	61.5	384	72.0	447
89.0	550	89.0	549	65.2	406	62.5	390
100.0	616	83.7	518	58.0	363	73.0	453
80.0	496	81.3	503	58.0	363	66.0	411
96.5	595	76.5	474	72.5	450	69.0	429
94.0	570			67.5	420	71.5	444
Average... 553		Average.... 510		Average.... 408		Average.... 430	

TABLE 4.—*Average results of tests of each series and mean deviation from average*

Series	Center loading		Cantilever, 12-inch beams		Cantilever, 9-inch beams	
	Average modulus of rupture	Mean deviation from average	Average modulus of rupture	Mean deviation from average	Average modulus of rupture	Mean deviation from average
	Lbs. per sq. in.	*Per cent*	*Lbs. per sq. in.*	*Per cent*	*Lbs. per sq. in.*	*Per cent*
A	543	5.2	516	5.2	553	4.7
B	511	3.5	506	3.4	510	5.0
C	413	6.1	409	4.6	408	6.2
D	417	5.0	421	6.2	430	4.2
Mean		5.0		4.8		5.2

The breaking load was weighed to the nearest tenth of a pound.

Tables I and 3 give the breaking load and computed moduli of rupture for each individual specimen. Table 4 presents a summation of the strengths, together with the mean variation from the average for each series.

There appears to be little variation between the test results obtained by the two methods of testing. The strengths obtained are essentially the same and the variation found between individual breaks averages the same in each case. It may be said that the testing of mortar beams can be performed as accurately with this cantilever device as by the customary method in the universal machine.

The retests of the 18-in. beams are of interest since they demonstrate that specimens broken under center loading may be checked by test of the two halves in the cantilever apparatus. In a series of tests extending over several periods of testing, one 18-in. beam could be tested at three different ages, the first test being by the center-loading method, and the other two by cantilever action. Such a method would furnish a more accurate index of the effect of age than could be obtained with three different specimens with the accompanying uncertainty of identical prepation.

Working drawings of the cantilever apparatus may be obtained upon request.

A 4-Wheel Drive Tractor

A 4-wheel drive, 4-wheel steer tractor has been placed on the market by the Atlas Engineering Co., Clintonville, Wis. Four important features claimed for this machine are: (1) Power is derived by applying the drive 15 in. from the center of the axle, thereby taking advantage of the additional lever arm in the diameter of the wheel. With power on all four wheels the drawbar pull is developed without carrying excessive weight.

(2) The operating cost is diminished to a minimum due to the method of applying the power.

(3) Complicated design has been eliminated, thus providing accessibility and easy serviceability.

(4) Ability to perform under adverse conditions.

The tractor has a rating of 25-45. Its wheel base is 100 in., and tread 64 in. The turning radius is 11 ft. The dimensions are, length over all, 171 in.; width over all, 80 in.; height to top of radiator, 67 in.; height over all, 77 in. The weight is 8,500 lb. The tractor has three speeds forward, 4½, 2½ and 1¾ miles per hour and one reverse speed. The motor is a 45 hp., 4-cylinder. The wheels have a diameter of 42 in. and a base of 12 in.

An interesting feature of the tractor is the standard patented self-cleaning

The Atlas 4-Wheel Drive, 4-Wheel Steer Tractor

track shoe designed to fit the tractor wheel. The design is such that it is possible to have practically two shoes on each wheel bearing at any period of revolution.

George F. Schlesinger Becomes Chief Engineer and Managing Director National Paving Brick Manufacturers Association

George F. Schlesinger, Director of Highways of the State of Ohio, has resigned his position, effective June 15, 1928, and will become Chief Engineer and Managing Director of the National Paving Brick Manufacturers Association July 1, 1928. The headquarters of the latter association, which are now in Chicago, will be moved to Washington, D. C.

Mr. Schlesinger was born in Xenia, O., educated in the public schools of

George F. Schlesinger

that city and graduated from Ohio State University with the degree of Civil Engineer in 1907.

For a number of years he engaged in the practice of his profession, principally in railroad engineering. He was a Division Engineer with the Rock Island Lines in Kansas and Missouri for about five years. In the fall of 1913 he became a member of the faculty of Ohio State University in the Department of Civil Engineering and left there during the war for government employment as an engineer on the construction of the Columbus Reserve Depot. He entered the Highway Department as Division Engineer in the Cincinnati District when A. R. Taylor was Commissioner. He was later promoted to Chief Engineer of Construction and resigned during the Herrick administration. When Governor Donahey appointed L. A. Boulay Director of Highways and Public Works July 1, 1923, Schlesinger was made State Highway Engineer. On Aug. 11, 1925, he was appointed to succeed L. A. Boulay as Director of Highways and Public Works.

Mr. Schlesinger is a member of the American Society of Civil Engineers, and past president of the Central Ohio Section of that society. He is also a past president of the Ohio Engineering Society, the Columbus Engineers Club and the Mississippi Valley Association of State Highway Departments. He is also serving as a member of the Executive Committee of the American Association of State Highway Officials.

Mr. Schlesinger has been a frequent contributor to engineering publications and has given a number of addresses at meetings of highway organizations.

New Type Lights for Muscatine, Iowa

A new type of ornamental novalux lighting unit is used in a new street lighting system recently put into service in Muscatine, Iowa. This unit, designed by the General Electric Company and bearing the designation Form 26, has a new design of ornamental support outside of the globe, and the casing is combined with straps and supports that slip over the top of a concrete standard. The extensions below the base of the casing can easily be slipped over the concrete standard and are of an ornamental design. Earlier types of General Electric casings were flat across the base and were arranged for mounting directly on top of the post, no part of the casing fitting over the side of the post. A total of 184 units was installed, each equipped with a 155,000-lumen lamp. Units are spaced 130 ft. apart on each side of the street in staggered formation.

How to Repair Chain Link Highway Guard

ONE of the important features of the chain link type of highway guard that borders hundreds, if not thousands of miles of highway is the ease and economy with which repairs can be made to it. That such guards are hit and thereby pulled out of shape, thus becoming in need of repair, is only to be expected since it was for the purpose of being hit that the guards were originally erected.

When a skidding car or speeding truck hits the chain link type of guard, that portion of the fabric which is struck is distorted and pulled out of shape. Its very construction allows for distortion rather than destruction or splintering. The fabric is woven similar to a net with the result that when pressure is exerted, the net, or guard, narrows and extends itself. It is this action that saves cars from damage and drivers from injury. Because there is nothing to spring the net back into place, however, the mutilated portion remains in need of repair.

For many highway engineers the repair of chain link highway guard is a seemingly difficult task. This impression is due entirely to lack of information, however, since this guard is as easily and readily repaired as it is erected or installed. Just how the chain link guard may be repaired is told in the following paragraphs and by the accompanying illustrations.

Because the guard is stretched along posts set on 10 or 12 ft. centers it is only seldom that a length of fabric longer than this distance needs to be replaced. The impact of a skidding automobile ordinarily will stretch out of shape only the few feet of guard

Fig. 2—Making the Chain Link Fabric Endless by Twisting the Wicket Into Place

that extends between posts, since the posts in themselves protect the remaining guard from mutilation. It is possible, of course, that the car or truck broke off one of the posts in which event two lengths of fabric might need replacement. Even in such instances, however, it is seldom necessary to replace more than 10 or 12 ft. of fabric since, generally speaking, only that fabric which comes into actual contact with the car is pulled out of shape.

If the latter is the case it will be necessary to use a block and tackle stretcher equipped with two clamps, as shown in Fig. 1. The mutilated section of the fabric may be taken out by bending back the top and bottom ties and merely untwisting one of the pickets that is immediately adjacent the distorted section. After taking out the mutilated section in this way, insert a new piece of the proper length. This can be done by twisting in a new picket between the old fabric and the replacement length, then pulling together the remaining ends (with the stretcher) until it is possible to twist in the final picket that will make the fabric endless.

In this way the chain link guard can be mended by the elimination of the distorted section, and the insertion of an equal length of new fabric with two straight pickets. This procedure would be the same regardless of whether a post had been broken or only the fabric between posts had been strained. In the event of the former, it merely remains to install a new post and staple the replaced fabric to it.

When stretching chain link fabric, the tightness should be tested only at the farthest point from the stretchers. If by gripping it at this far distant point, the average man cannot pull any slack in the diamonds, the fabric is tight enough.

Proposed Highway Legislation in Uruguay.—During the last sessions, the Chamber of Representatives has been discussing a bill introduced by the Minister of Public Works, for the construction of highways at a cost of over $30,000,000. It is intended to obtain this sum by internal or external loans, by a 10 per cent additional customs duty on automobiles and accessories, an additional customs duty of one centesimo per liter on gasoline and one centesimo per kilo on oils, and various assessments on real estate within certain distances of the roads. On April 23, the Chamber by a large majority resolved to abandon the discussions of the Montevideo-Colonia Railway Bill and take up a bill for the construction of a highway between Montevideo and Colonia instead.

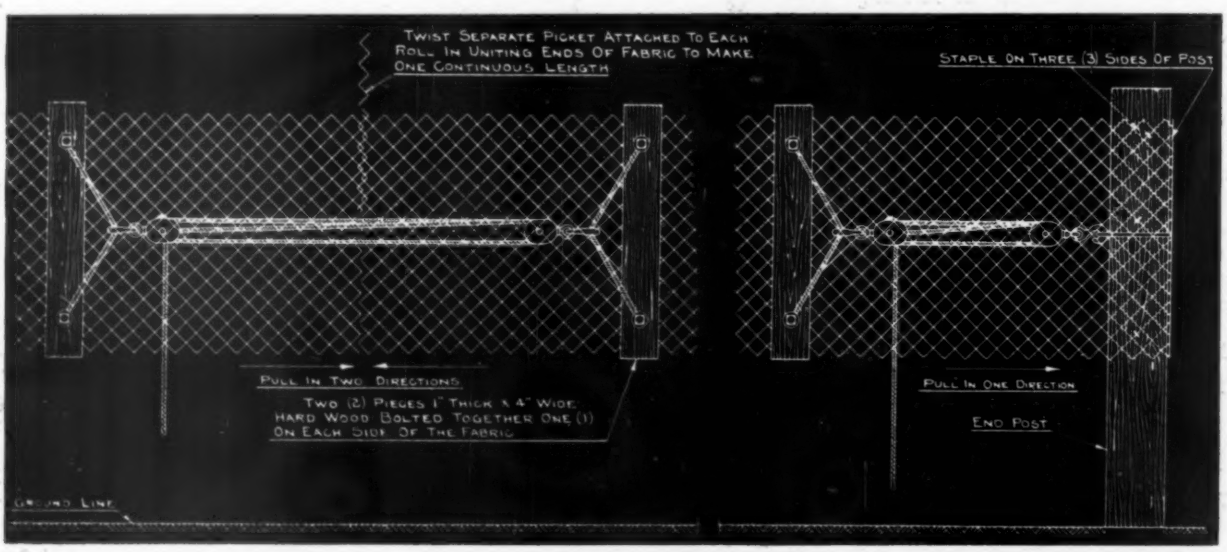


Fig. 1.—Method of Repairing Chain Link Highway Guard After the Distorted Portion of the Fabric Has Been Removed

Dust Prevention on Gravel Roads

Methods in Wisconsin Described in Paper at 17th Annual Road School

Division Engineer, Wisconsin Highway Commission

THE problem of dust prevention on our highways is a very serious one and the traveling public and adjacent property owners are demanding that some form of dust prevention must be adopted. Furthermore, those in charge of maintenance of gravel or fine crushed stone roads find that it is necessary to add from 100 to 450 cu. yd. of material per mile of road each year in order to replace the metal that has been kicked over into the ditches, or ground up under traffic and blown away in the form of dust.

The dust in itself seriously interferes with the safe travel on our highways and many accidents are caused by it. It increases the cost of maintaining our highways greatly, due to the loss of metal, and also, increases the cost of traveling on them. For instance, the dry cleaning of our clothes alone is a big item and amounts to over a million dollars per annum which is a very conservative estimate for the state.

Dust Eliminating Materials.—There are several materials available which can be used to eliminate the dust. They are water, road oils with a bitumen content such as tars and asphalts, and calcium chloride. Water is discarded immediately because it requires a constant application and the expense would be too great.

Tar and asphaltic road oils and calcium chloride will give good results when applied properly. The tar should be an oil of low viscosity and have a specific gravity of 1.00 to 1.1 at 77°F.

The asphaltic oil should have a viscosity at 122°F. of approximately 35, a 50 per cent to 60 per cent content at 100 penetration and a specific gravity of 0.95 to 1.00 at 77°F. Particularly for first application work, the above mentioned asphaltic road oils, should be used as it will give far better penetration. The higher the specific gravity of the road oils, the less danger there will be of having the oil float away on the water during a rain.

The calcium chloride can be any one of the commercial brands. There should be approximately 20 per cent of binder in the road metal, as the binder helps to retain the moisture and thereby reduces the number of applications necessary.

There are two methods of handling the bituminous work, namely, the surface treatment application, and the "Turn Over or Surface Mixer Method".

Surface Treatment Method.—The surface treatment method contemplates the impregnation of the surface crust of a completed road with a road oil.

The gravel or fine crushed rock surface, having all material passing a one in. ring, is the most ideal surface to treat because it can be thoroughly bladed and worked to secure a perfectly smooth surface prior to oiling.

Two physical features of the road to be treated are most important. There must be an adequate thickness of surfacing, and the binder in the metal should not be heavy clay. A waterproof bituminous cover holds the moisture in the road and clays of this character remain saturated, unstable, and without cementing value.

The existing surface, if it is rough or has any holes, should be lightly scarified and then trued up with a large road grader. Second, the surface should be swept over with a power sweeper and if necessary hand brooms should be used. The sweeping operation should be continued until all patches of fine loose material are removed and until the rock in the surface is exposed. The thorough sweeping will give an excellent non-skid surface. The fine or loose material, if suitable for covering, is placed in a windrow along the shoulder, or if only one-half of the road is treated at a time, it is placed slightly to the left of the center line. The proper preparation of the surface, including thorough brooming is necessary to the production of an uniformly smooth and durable surface. The oil is then applied at the rate of ¼ to ⅓ gal. per square yard by means of a pressure distributor, immediately after scarifying the roadway.

Sufficient time to permit the oil to penetrate and be absorbed should be allowed. Two days would be ideal. However, if the road cannot be closed, one-half of the road can be treated at a time.

Following the first application, if a cover is applied, the roadway is bladed and the oil coated screenings will fill any depressions; or, if the depressions are marked it will be necessary to patch with a pre-mix of oil and screenings.

The second application is then spread at such a rate that the total quantity of oil would not exceed ½ gal. per sq. yd. One should obtain a penetration of about one inch. After the second application a suitable covering material should be applied at the rate of 40 to 100 cu. yd. per mile.

In the surface treated method, it is not the intention to secure a mat. However, if heavy oils are used a mat will be produced so it is advisable to use light oils of low viscosity. If a heavy oil and one of high viscosity is used, 100 per cent additional cover metal will be required.

Turn Over or Surface Mixing Method.—This treatment is especially adapted to our fine crushed rock and gravel roads which are in need of additional material to restore their thickness or which on account of lack of binder are not tightly bound. In this type of treatment the lower part of the road metal or base should be firmly compacted.

The mixing method is particularly adapted to roads on which the traffic cannot be shut off during the time required for absorption of the oil, for the loose surface in itself encourages slow driving, and the vehicles pick up a minimum amount of the oil.

In the surface mixing method, the surface, if well compacted, should be scarified to a uniform depth of 1½ to 3 in. according to the thickness of bituminous surface desired. The light oil is then applied in two or three applications of about ½ gal. per square yard. After each application, the oil and loose stone are partially mixed with two disk harrows, working opposite each other. The material should be bladed repeatedly into windrows and respread until a uniform color is obtained. It is finally spread to the desired crown and the road is then opened and continually dragged or bladed while it is being compacted by the traffic.

The surface treatment and surface mix methods produce a road of higher type than a road treated only for dust palliative purposes. They greatly resemble other high type bituminous construction in appearance. If the work is carefully and skillfully prepared and treated, a very smooth riding road is obtained. When well maintained, it compares favorably with any good bituminous macadam, but at its worst with poor and neglected maintenance, it becomes very rough and choppy. On a good job, there will be no dust and tractive resistance and tire wear will be low.

The surface treatment method will cost from $400 to $800 per mile and the surface mixed method will run from $1,200 to $1,600 per mile. The higher range of figures will govern when the quanity of cover material required is large. The tar oils will cost about $0.11 per gallon and the asphaltic oils about 0.06 per gallon F. O. B. destination.

Where the funds are available the surface mixing method should give the most economical results over a period of three years. In cases of roads which do not have a full depth gravel on them, it will be uneconomical to use either method and a dust palliative treatment should be used, because the results secured will not carry over into the second maintenance season.

The application of only a dust palliative will cost from $3.00 to $4.00 per mile based on ⅓ gal. to the square yard, and 18 ft. wide.

Our untreated gravel roads are requiring about 300 cu. yd. of additional material per year and one can readily assume that they are always rough. The cost of this 300 cu. yd. of material will, in practically every case,

pay at least for the surface treatment work.

Calcium Chloride.—Calcium chloride is a substance which has the property of absorbing moisture from the air to the extent that it will dissolve itself, penetrate the road surface, and keep the road damp, firm and free from dust during the summer season.

Before applying any calcium chloride, it is necessary to properly shape the roadbed and rake out any coarse stone one inch in size. If the road is on a sandy subgrade or the gravel is of very sandy nature, 10 to 15 per cent clay should be added and then thoroughly mixed with the sandy gravel. The clay binder helps to hold the moisture, thereby prolonging the life of each application. The reverse holds true and if there is an excess of clay binder, sand should be added. A blade grader must be operated on the road the following day after each application in order to obtain a more uniform mixture.

It comes in moisture proof sacks containing 100 lb. The method of application is to have a truck, loaded with calcium chloride, pulling a spreader, similar to a lime spreader. The spreader is hitched up close to the truck so that the men on the truck can dump the sacks directly into the spreader. The material should be spread at the rate of one pound to the square yard. The speed of the truck can be so regulated as to spread the required amount which can be determined readily by trial. It is very essential that the truck spread be kept uniform so that an even distribution of material can be obtained. Rubber tires on the spreader will greatly facilitate the uniform distribution of the calcium chloride. Spreading at the rate of 1 lb. to the square yard will require 5 to 6 tons of calcium chloride per mile, for an 18 ft. roadway. The material will cost about $30.00 per ton or $180 per mile. The cost of applying will depend upon the haul, and will run from $0.75 to $1.50 per ton which gives a total cost of $190 per mile for an 18 ft. width.

Six to eight weeks after the first application, it will be necessary to place a second application of ½ lb. to the square yard. If the season is unusually dry, another ½ lb. application will be necessary. Therefore, the season's cost for the material will be $300 to $400 per mile.

The sucess of any of the treatments mentioned will depend largely on the maintenance organization. It is most essential that the maintenance of the treated road start immediately and be continuous, otherwise the work should not be undertaken. Where road oil is used the smallest spots must be repaired or touched up immediately with premixed screenings and oil. Much consideration should be given the traveling public where oil treatments are used, because damage to traffic may more than offset the benefits resulting from the treatment.

In concluding I hope I have brought out the different methods of dust prevention and also the processes for giving the traveling public far betted service on our large mileage of low type surfacings. The methods outlined will eliminate the dust, the loosely bound surfaces, decrease tire wear, give lower fuel consumption; increase the smoothness, and make for safer and more enjoyable highways.

We have and will continue to have a large mileage of low type surfacings because it is almost impossible to secure the necessary funds to build all of our roads of the high type surfacings. The maintenance problems on these low type surfacings is confronting us seriously at the present time and the traveling public is demanding that they be given better traffic service immediately.

$5,300,000,000 Spent in 1927 for Motor Vehicle Operation and Maintenance

An average of $229 was spent by each motorist in the United States during 1927 in the operation and maintenance of his car, according to figures compiled by the American Motorists Association. Of this sum $101, or 44 per cent, was expended for fuel and lubricants, this being the largest item in the motorist's annual operation and maintenance bill.

The $229 figure does not take into account depreciation. The average life of a passenger automobile, however, according to Federal government statistics, is seven years. During 1927 the average retail price per passenger car in the United States was $953 which, based on a 7 year life expectancy, would mean an average depreciation of $136 per year. From this figure, plus the average upkeep cost of $229, it will be seen that the general average cost of operation of a motor car, plus depreciation, is $365 per year or $1 per day.

The second largest item on the motorist's maintenance bill is for time of mechanics in doing repair work, the motorist expending in 1927, for this item, an average of $47. His replacement parts cost him $41 during the year and his average tire bill was $40. The total operation and maintenance bill of the 23,127,000 motorists of the country last year aggregated $5,300,000,000, the figures show.

Comparing the cost of operation in 1927 with 1926, the Association's figures show that last year the cost was 5 per cent more than during 1926, when the average operation cost was $219. Comparative figures, between the two years, however, it is pointed out by J. Borton Weeks, President of the Association, do not indicate that operation costs are necessarily increasing. The difference is explained primarily by greater mileage made by the average motorist in 1927 which means an increase in not only gasoline consumption but in tires and wear of replacement parts.

Good Roads Increase Life of Motor Vehicles

The average life of motor vehicl in the United States has been increase 14 per cent, largely as a result of go roads, according to the American R Builders' Association.

A total of 1,825,581 vehicles wer sent to the scrap heap during 1927, th association states. This was 12.05 cent of the total registration at the beginning of the year, indicating should this average maintain, the en tire stock of motor cars would be placed every 8¼ years. The average life of a motor vehicle was formerl estimated at 7 years.

New York led all states in the number of cars scrapped, that state discarding 149,372 vehicles. Nevada discarded only 813 vehicles, the smallest number of all states. Arkansas held the highest junkage rate, that state discarding 16.6 per cent of all vehicles registered at the beginning of the year. South Carolina discarded only 2.8 per cent of the cars registered.

All but two states registered more vehicles in 1927 than in 1926. They were Florida and Arkansas, the former decreasing by 6,828 cars and the latter by 2,851. North Carolina recorded the largest comparative increase, that state gaining 11.8 per cent over 1926. National registration was increased 5.1 per cent.

Most of the scrapped vehicles were partially salvaged, the American Road Builders' Association says. Metal parts were in many cases adapted to vehicles still in use, while a large number of motors were installled in boats or used as stationary power plants. The bodies were burned or cast into dump heaps. One New York salvaging agency maintains a 7 acre plot of ground for storing undamaged parts of disassembled vehicles.

In tabulating the figures pertaining to the discard of motor vehicles, the American Road Builders' Association has considered all cars scrapped which were registered in 1926 but not reregistered during 1927. Some of these cars, however, may have been registered in other states, making the figures for each individual state slightly in error, although the national figure would be reasonably accurate.

A $2,850,000 Road in Italy.—A new road from Biella to Milan, Italy, to cost about $2,850,000 is soon to be built, according to local authorities. Approximately $1,925,000 has already been subscribed. Work will begin early this summer, it is believed.